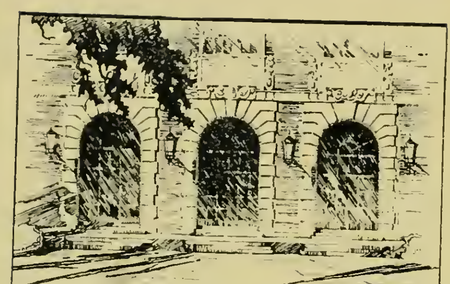

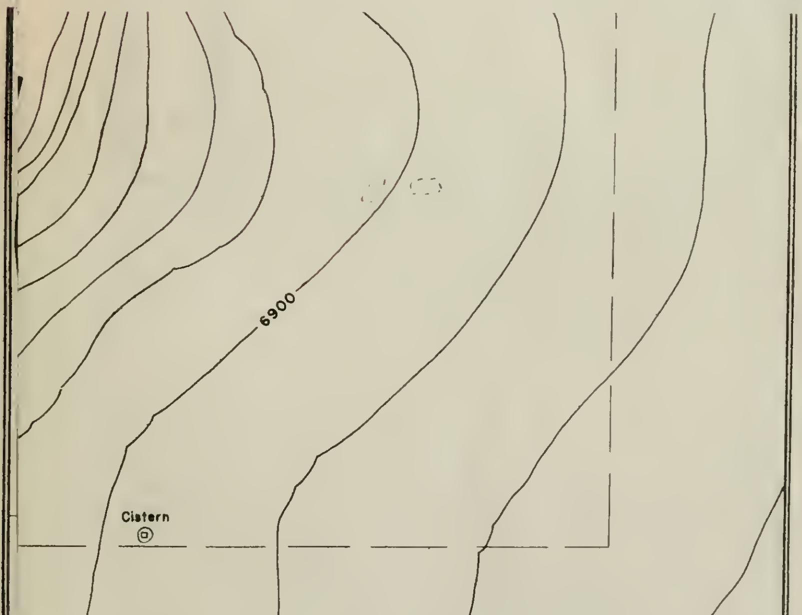

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Map 1. TOPOGRAPHIC MAP OF LOWRY PUEBLO AND GREAT KIVA

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LOWRY RUIN IN SOUTHWESTERN COLORADO

BY
PAUL S. MARTIN
CURATOR, DEPARTMENT OF ANTHROPOLOGY

WITH REPORTS ON

MASONRY OF LOWRY RUIN AND OF THE SOUTHWEST

BY
LAWRENCE ROYS

AND

SKELETAL MATERIAL FROM THE LOWRY AREA

BY
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THE JULIUS AND AUGUSTA N. ROSENWALD ARCHAEOLOGICAL EXPEDITION FUND

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PREFACE

This publication embodies the results of archaeological research made at Lowry ruin in southwestern Colorado during the years 1930–31 and 1933–34 by the Field Museum Archaeological Expedition to the Southwest. This area was chosen because little intensive work has been carried on there. Permission to excavate at this site, situated on federal public domain, was obtained from the Secretary of the Department of the Interior.

The Expedition, with myself as leader, was financed from the income of a fund donated by the late Julius and Augusta N. Rosenwald.

Mr. Stephen C. Simms, Director of the Museum, and my former chief, the late Dr. Berthold Laufer, recognized the desirability of undertaking archaeological research in the Southwest and encouraged me in every possible way. To both I am very grateful.

The success of any expedition depends largely on its personnel. This Report would be incomplete if I failed to acknowledge my indebtedness to those persons who served without pay and who, by their loyalty, resourcefulness, and keen observation, made possible any success which the Expedition may have achieved.

I particularly wish to mention the following individuals: Mr. Clyde Allan; Dr. Gerhardt von Bonin, Assistant Professor of Anatomy, University of Illinois College of Medicine, who carefully excavated the few skeletons found and whose report on them appears in this publication; Mr. Robert Burgh, of the National Park Service, who served as surveyor and cartographer for the Expedition and whose excellent maps are included in this Report; Professor Pierce Butler, of the University of Chicago, who very generously permitted me to use his Gurley Transit, with which all the survey work was done, and who made many valuable suggestions concerning the mapping and the excavating; Mr. Paul Cooper; Mr. Carl T. Lloyd, my administrative assistant, who had charge of the field photography and who developed the films under very adverse conditions; Mr. Vergil C. Lohr, then of the University of Chicago, who acted as camp-cook for one summer; Mr. Frank McArthur; Mr. Lawrence Roys, who helped me institute a thorough study of pueblo masonry and whose report on this undertaking is published in this Report; Mr. Michael Sapir; Mr. Watson Smith, who assisted in several legal problems

and who took charge of potsherd stratigraphy and wall constructions; and Mr. Richard P. Wheeler, who helped work out certain problems about the Great Kiva. Mr. Wheeler also checked over the statistics on masonry.

Most of the digging was done by paid workers who live near the ruin. For their interest and painstaking work, I wish to thank Mr. Al Lancaster and Mr. Marion Clark, both of whom acted as my foremen, and Messrs. S. T. Bangs, Laurence Campbell, Roy Herren, Harold Long, Graham Marr, Emory Retherford, Jack Shrader, and Jack Yates.

I owe more than I can ever repay to Mr. and Mrs. Clyde D. Long, who permitted us the unlimited use of their log cabin, their cistern, their tools, and their horses. At all times we had free use of the ranch. Mr. Long, although a semi-invalid, was always willing to help us construct and carry out any plan that I conceived, be it a 50-foot photographic tower or a cellar. Mrs. Long provided us with excellent food and was always able, by means of some legerdemain known only to her, to find enough to accommodate unexpected guests; and this, despite the fact that we had no ice-box and that we were thirty-five miles away from a grocery store.

This opportunity is taken to express the appreciation of the Museum and of myself to Mr. Jesse L. Nusbaum, then Director of the Laboratory of Anthropology, in Santa Fe, New Mexico, and Consulting Archaeologist for the United States Department of the Interior. In dealing with the violent opposition of a misinformed homesteader, who believed he had the right to bar us from working in the ruin, Mr. Nusbaum aided me by conducting negotiations with the United States Land Office officials, so that the disputes were settled amicably and expeditiously.

The excavations were greatly expedited in 1934 through the aid given by the Montezuma County Emergency Relief Administration, which furnished from six to ten men for a period of nine weeks. Special thanks are due to Mrs. Alice Van Diest, Director of Colorado State Relief, and to Mr. Harry R. Kauffman, Administrator of the Montezuma County Emergency Relief Administration, and his associates, for their helpful cooperation.

Drawings in this Report signed C.F.G. were done by Mr. Carl F. Gronemann, Illustrator on the Museum staff; and those signed R.L.Y., by Mr. Robert L. Yule, Assistant in the Department of Anthropology.

PAUL S. MARTIN

LOWRY RUIN IN SOUTHWESTERN COLORADO

I. INTRODUCTION

Location

Lowry ruin is situated on a mesa top in Long. 108° 54′ W., Lat. 37° 37′ N., about thirty-two miles northwest of the town of Cortez and nine miles west of the Ackmen Post Office, in the northwest Quarter of Section 2, Township 38 North, Range 19 West, N.M.P.M., lots 6 and 7, Montezuma county, Colorado (Figs. 1, 2). The altitude, as given by an altimeter which was corrected and later checked eight times, is 6,900 feet above sea level. According to Gladwin's system of designating ruins (Gladwin, 1928), it is situated in Colorado A:5.

Physiographic and Biotic Conditions

The region about the ruin is a gently rolling, dissected plateau of a type common in the Southwest. Although fairly flat over great areas, the surface in many places has been cut by streams into narrow, steep-walled, and sometimes deep, canyons, which are dry except after heavy rains. A few wind-eroded caves have been formed and in them I have noticed small cliff-pueblos.

The country near the ruin is open in all directions for some distance; but farther away and to the north lie the La Sal Mountains; to the east, the San Miguel and the La Plata Mountains; to the south, the Ute or El Late Mountains (Plate I); and to the west, the Abajo Mountains (known locally as the Blue Mountains).

Drainage is to the southwest. There are no rivers in the immediate vicinity; but forty miles south of the ruin flows the San Juan River, and about thirty miles east, the Dolores River.

The geology of the ruin area is comparatively simple, consisting of a series of horizontally bedded sandstones, shales, conglomerates, impure limestones, and cherts of the Jurassic and Cretaceous ages. The Jurassic, which lies unconformably under the Cretaceous, is represented by the McElmo formation, and the Cretaceous, by the "Dakota." Outcrops of these formations of varying thicknesses may be observed in the walls of the adjacent canyons. The Mancos and Mesa Verde formations (Cretaceous), which occur about thirty miles to the southeast at Mesa Verde National Park, are locally absent (Coffin, 1921, p. 28).

Climatological data for four years obtained from the nearest United States Weather Bureau Observation Station, at Northdale (Dolores County), which is about twenty miles in an airline northwest of Lowry ruin, are as follows:

	Degrees F.
Highest temperature	98.0
Lowest temperature	–42.0
Mean annual temperature	43.1 to 47.8
	Inches
Greatest annual precipitation (1931)	16.58
Least annual precipitation (1934)	7.03
Greatest total snowfall (1931)	67.40
Least total snowfall (1934)	13.00
Mean annual precipitation	10 to 15

Number of clear days	160 to 182
Number of cloudy or partly cloudy days	184 to 205
Prevailing direction of wind	S. to S.W.
	Per cent
Relative humidity (noon)	about 35

From these data it may be observed that the range of temperature is great and that the precipitation is scanty.

It is not surprising, then, to find that springs are widely scattered. At present, there is an intermittent seep near the head of the canyon which lies east of the ruin. This well, which was dug in recent times, may yield in the summer fifty or sixty gallons daily. In the floor of the canyon west of the ruin there is another modern well. This spring may produce in the summer as much as 150 gallons daily. It is quite likely that the Indians, who lived in former times in this region, had as much difficulty in obtaining water as do the farmers today. Most people living in the vicinity of Lowry Pueblo must haul their stock and domestic supplies of water from three to nine miles. The water for Field Museum camp was brought in barrels from a canyon spring four miles distant. In 1934 the local branch of the Federal Emergency Relief Administration drilled a well 500 feet deep; but the project was abandoned at that depth as hopelessly unpromising.

I know of no ancient well in the canyons adjacent to Lowry Pueblo. About five miles east of the pueblo, however, an ancient spring was located and cleaned out by Mr. Courtney Dow, who lives in the neighborhood and who first interested me in Lowry Pueblo. Upon cleaning the well, its original dimensions were found to be about six feet square. The sides were timbered with ancient logs laid crib-fashion. Six pieces of Mancos black-on-white pottery and about fifty prayer-sticks were dredged from the bottom. I assume that these artifacts were thrown into the spring as offerings.

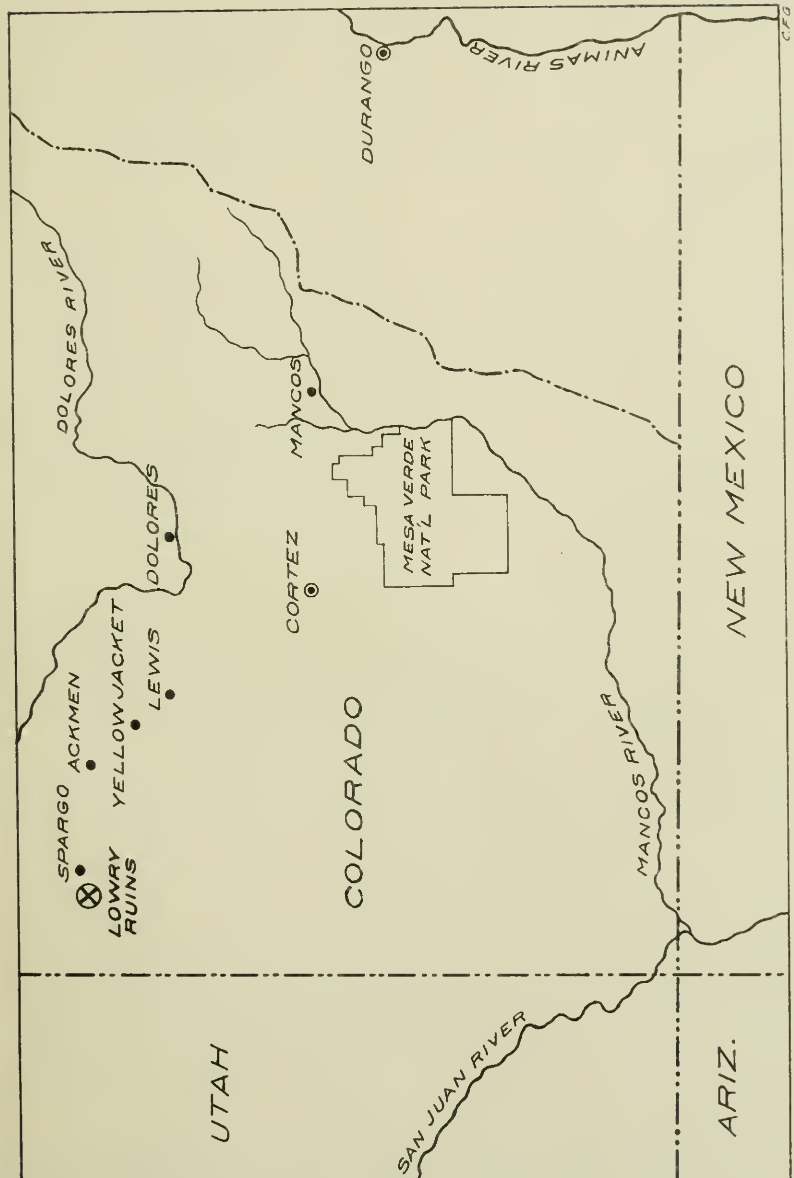


FIG. 1. Lowry District.

The most conspicuous trees and shrubs of the area about the ruin are pinyon (*Pinus edulis*), juniper (*Juniperus monosperma*), yucca (*Yucca baccata*), Southwestern cottonwood (*Populus Wizlizeni*), gray saltbush or "chico brush" (*Atriplex canescens*), round-leaved saltbush (*Atriplex confertifolia*), grease-wood (*Sarcobotus vermiculatus*), Rocky Mountain bee plant or Guaco (*Cleome serrulata*), prickly pear (*Opuntia* sp.), sagebrush (*Artemisia tridentata*), and rabbit brush (*Chrysothamnus* sp.).

A list of the more important mammals which were or still are present would include the buffalo, antelope, mule deer, mountain sheep, western white-tailed jack rabbit, Texas jack rabbit, Rocky Mountain cottontail, Colorado cottontail, porcupine, Moki kangaroo rat, golden pocket gopher, two species of wood rats, mountain or pack rat, tawny deer-mouse, pale grasshopper mouse, cliff mouse, Gunnison prairie dog, rock squirrel, antelope squirrel, two species of chipmunks, badger, Great Basin spotted skunk, ring-tailed raccoon, black bear, gray fox, gray wolf, coyote, bobcat, mountain lion, brown bat, little California bat, long-eared bat, and western bat (Cary, 1911; Edward R. Warren, 1910).

Some of the most characteristic breeding birds are the sage hen, ash-throated flycatcher, Woodhouse jay, magpie, pinyon jay, canyon wren, chestnut-backed bluebird, cedar waxwing, western blue grosbeak, house finch, Arkansas goldfinch, canyon towhee, and desert sparrow.

Batrachians and reptiles are not very common. The following, however, occur within the area: the spade-foot toad, collared lizard or mountain boomer, desert lizard, horned toad, whip-tailed lizard, garter snake, bull snake, and rattlesnake.

Irrigation was not practiced, so far as I could discover, by the builders of Lowry Pueblo. I should, however, like to call attention to the shallow, dry foss or ha-ha about one foot in depth and from fifteen to twenty feet wide. This ditch lies between the Great Kiva and the Pueblo extending for a half mile or more north and south beyond the ruin. I was unable to determine whether or not this shallow depression was of a natural or an artificial origin or to determine its purpose. I never observed any water in it.

Located at the place where an arroyo drains into the east branch of Cow Canyon and about two miles southeast of the ruin is a large crescent-shaped prehistoric dam, which still effectively impounds the surface drainage waters. Its base is formed of stones, irregularly placed, and the upper portion, of adobe. It measures six feet from

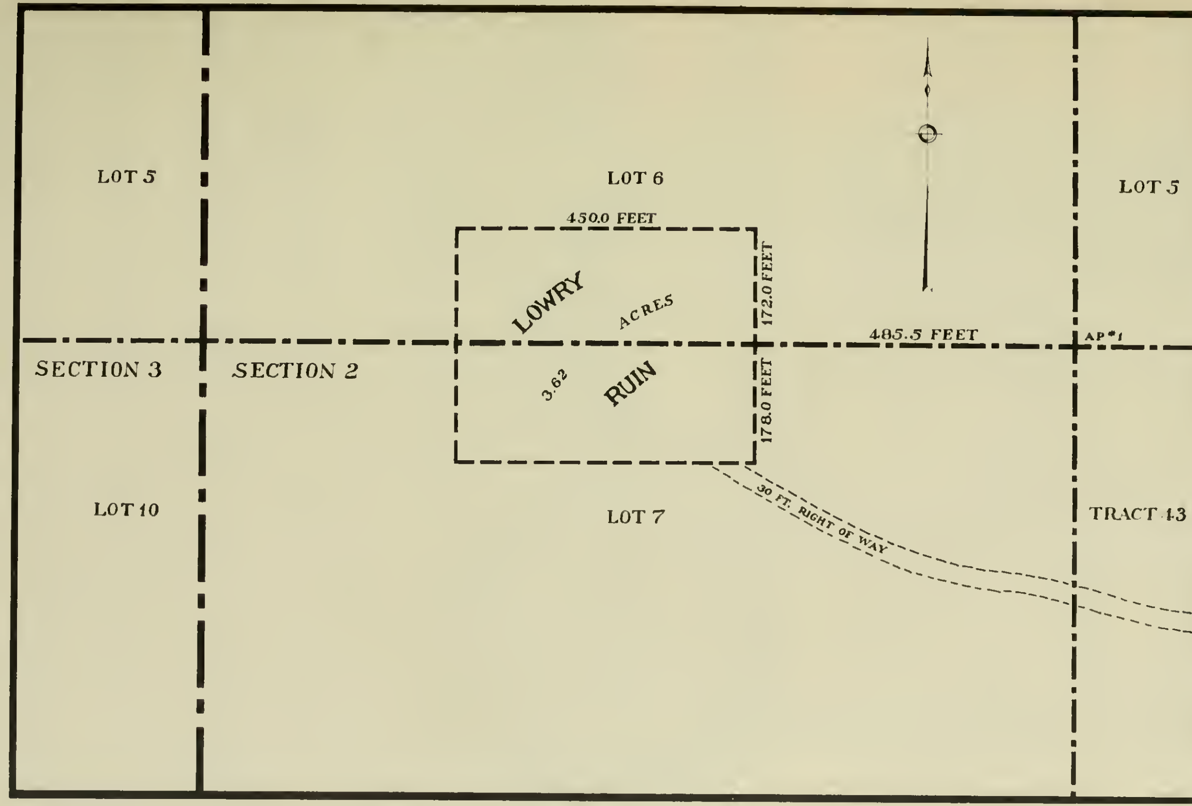


FIG. 2. Detail of township plat showing location of Lowry Pueblo.

base to top and 225 feet from tip to tip. After a heavy shower, a body of water, perhaps half an acre in extent and fifteen inches deep, is caught and is retained, because the floor of this reservoir is of rock.

Agriculture was undoubtedly practiced in ancient times by these pueblo Indians, for burned maize, squash, and beans have been found in several rooms. But exactly where the fields lay is not known. It is possible that the planting may all have been confined to the floors of the canyons, which here are broad and shallow. Frost, however, generally strikes first these lowland spots and thus renders them less desirable for cultivation. Agriculture may also have been practiced on the mesa tops, where, today, fair crops of maize and beans are produced.

History of the Site

Lowry Pueblo was apparently not visited by any of the members of the Domínquez-Escalante Great Basin Expedition, although they camped not more than eight miles from it, probably on August 13, 1776.

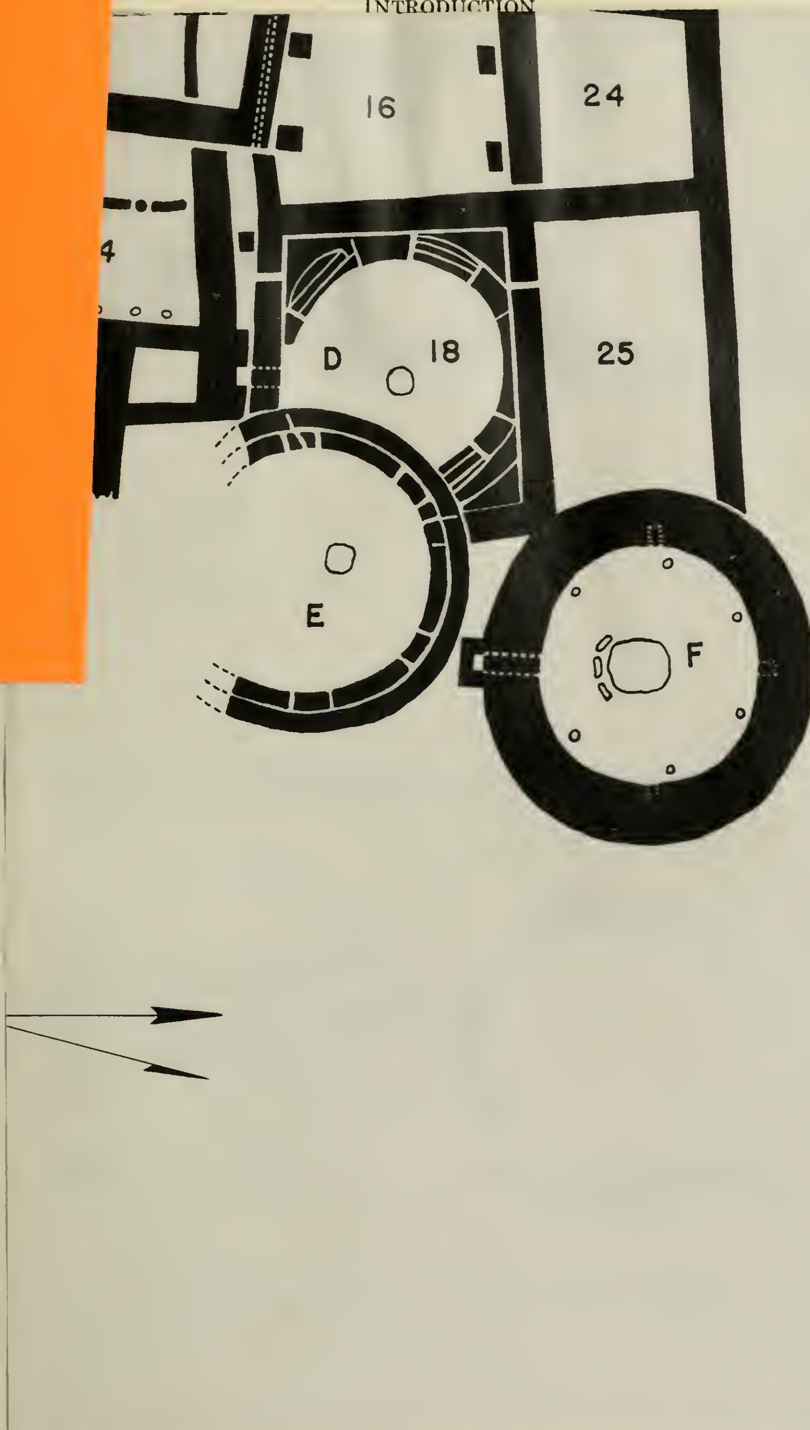
In the summer of 1859, another expedition, called the Exploring Expedition from Santa Fe, New Mexico, to the Junction of the Grand and Green Rivers of the Great Colorado of the West, following more or less closely what is now a state highway, passed within six or seven miles of the pueblo (Newberry, 1876).

Both Jackson, in 1874, 1875, and 1877, and Holmes, in 1875–76, were in southwestern Colorado and both have written brief reports on the ruins they observed in McElmo and Hovenweep canyons, which lie from eighteen to twenty miles south of Lowry Pueblo (Jackson, 1876, 1878; Holmes, 1878).

I find, however, in Hayden's *Atlas of Colorado* (Hayden, 1881), that a 6,800-foot contour-line is drawn through the spot on which Lowry Pueblo is located. Although the surveyors must have passed within one-eighth of a mile of the ruin, if not over it, I cannot find any reference to this ruin in their text.

According to Miss Anna F. Robison, who has been gathering historical data from the pioneers of Montezuma County, Lowry ruin must have been seen by many cowboys who rode all through that vicinity in the 1880's. Those cowboys, however, who have been interviewed by Miss Robison do not remember the ruin.

As far as I can ascertain, Fewkes was the first to report and to photograph Lowry ruin. In his report, he calls it "Acmen Ruin," (Fewkes, 1919, p. 29) and says:


16
24
4
D
18
25
E
F

Map 2. GROUND PLAN OF LOWRY PUEBLO

"Following the Old Bluff Road and leaving it about five miles west of Acmen [now spelled Ackmen] post office, one comes to a low canyon beyond Pigge ranch. The heaps of stone or large mounds cover an area of about ten acres, the largest being about fifteen feet high. East of this is a circular depression surrounded by stones, indicating either a reservoir or a ruined building.

"The top of the highest mound—no walls stand above the surface—is depressed, like mounds of the Mummy Lake group on the Mesa Verde. This depression probably indicates a circular kiva embedded in square walls, the masonry of which, so far as can be judged superficially, is not very fine. . . ."

The ruin is actually about nine miles west of Ackmen Post Office. I am somewhat surprised that Fewkes was not more impressed with the circular hollow lying to the east and that he did not suspect its true nature—the ruin of a Great Kiva. The plate reproduced in Fewkes' report is a photograph of the ruin looking west and north and is similar to Plate II of this Report. The depression in the top of the highest mound is Kiva A on my ground plan.

In 1928, I examined Lowry ruin and described it briefly (Martin, 1929, pp. 5–6). I overestimated the depth of the debris in the largest mound by fifteen feet. Excavations have likewise shown that the first-story rooms are not well preserved, as they are at Aztec ruin, Aztec, New Mexico, and that the outside diameter of the Great Kiva finally proved to be twenty feet less than I had estimated.

APPEARANCE OF RUIN BEFORE EXCAVATION

Lowry ruin consists of a pueblo, the long axis of which runs north and south, and a Great Kiva, which lies about 200 feet to the east.

Before excavation, the ruin appeared as an oval-shaped mound (Plates II–IV). It had been formed partly by dust carried from the southwest by storms and partly by the gradual disintegration and collapse of the dirt-covered log roofs and of the upper portions of the walls. The mound was overgrown with sagebrush and was strewn with potsherds and wall stones. It rises thirty feet above the plain east of the Great Kiva, although the tallest walls, none of which were visible prior to excavation, stand only thirteen feet high. This apparent discrepancy is due to the fact that the pueblo was erected on a natural knoll. Just east of the Pueblo ruin is the Great Kiva, which before excavation resembled a small crater. The rim was covered with building stones. It was approximately eight feet above the lowest point in the center (Plate V).

Problems

This Report is intended to present for interpretation the data gathered and to describe the results of the excavations along with my explanations and my personal opinion. Possibly this work will contribute towards the discovery of some of the forces which caused the gradual rise of the Pueblo Indians from a low to a higher cultural state. I likewise hope that this study may perhaps be one of the tesserae which will be used in combination with others for completing the mosaic of Pueblo history which archaeologists working in the Southwest are slowly composing.

This general synthesis, however, can not be produced without facts. Facts must be gathered in as scientific a manner as possible, and they, together with the specimens recovered, must be subjected to close study and must be carefully compared, described, and classified. But the mere gathering and presenting of facts will not alone accomplish this purpose; insight into these facts must be acquired. Then, and in this way, historical conclusions must be sought and may be achieved.

In 1930, after a lapse of twenty years, Field Museum resumed archaeological research in the Southwest. Colorado was chosen because, with the exception of the somewhat limited excavations undertaken by a few archaeologists (Morley, 1908; Kidder, 1910; Prudden, 1914, 1918; Martin, 1929, 1930; Woodbury, 1932; Brew, in preparation) little work had been done in the thousands of ruins which are scattered over the mesas lying west and north of Mesa Verde National Park, in southwestern Colorado and southeastern Utah.

Lowry ruin was selected because the region in which it is located is rich in prehistory and may be the area in which pueblo architecture and kivas developed. Also, the mound and refuse heaps were sufficiently large to allow the use of stratigraphic methods for determining the sequence of pottery types for this region. Such a coordination might be of great value in allotting the many small ruins in that vicinity to their proper, relative places.

Moreover, investigation of Lowry ruin was prompted by still another reason, for cropping out in a region which was traditionally considered to be a Mesa Verde culture-district, were several Chacoan features: Chaco-like potsherds and a large depression which looked as if it might be a Great Kiva, a type hitherto associated only with Chaco architecture. Yet, when work was started on this ruin (1930), the known range of Chaco culture-traits was limited to Chaco Can-

yon, where they reached their highest specialization, to Aztec Ruin, to the area about Gallup, New Mexico, and to the region near Pagosa Springs, Colorado (Kidder, 1924, pp. 55–56). Thanks to the recent work of Gladwin (1931, 1934) and Roberts (1932) our information concerning the distribution of Chaco culture-traits is now more complete. Reference to this subject will again be made in Chapter VIII.

Thus I hoped, by exploring as intensively as possible, to secure many data. Then, by arranging them in an orderly temporal sequence, I might attain a historical perspective which would permit me to solve specific problems, such as the mechanics of the growth of a particular pueblo, the classification of masonry, the architectural skill of these Pueblo Indians, the size of the population at various periods and its changes, the length of time that the pueblo was inhabited, the pottery sequence, and the cultural and chronological relationship of this pueblo to other large villages in New Mexico and in Arizona.

METHODS OF EXCAVATION

Two long trenches were first dug, one of these, 200 feet long, running northwest and intercepting the main ruin at its southeastern corner; the other, 100 feet long, running southwest to the northeastern side of the ruin (Plates VI, VII). By means of these two main and several branch trenches I was able to chart in a rough way the location of some of the outside walls and corners and the general shape of the ruin. As stated previously, I also found out that the pueblo had been erected on a natural knoll and that the terrain east of the ruin sloped naturally upwards and that it was not composed entirely of debris and refuse, as I had imagined.

Excavation in the rooms, kivas, and refuse heaps was conducted in such a way that a careful record of all potsherds was obtained, the sherds yielded by each well-defined layer or by each foot of ground being separately sacked and catalogued. Fallen roof timbers and all specimens were photographed *in situ*. Digging in the upper portions of the rooms, which were filled with rocks and very hard dirt, had to be done with a pick and shovel. Since these upper layers, however, were always sterile and represented the fill of the last few centuries, there was little chance of harming any specimens with the picks. After these hard strata had been disposed of, the soft dirt below was carefully troweled and spaded over and then thrown out for a team and scraper to haul away. I found that the use of a mine dump-car and tracks did not serve my purpose very well and this equipment

was used only in 1930 (Plates VIII, IX). Floors were easily located because they were much harder than the dirt which lay immediately above. When they were struck, the workmen used trowels only until they were certain that no pottery, burials, or other valuable material was present. After the floors had been cleaned with whiskbrooms, and after photographs, notes, and measurements had been secured, a trench was cut through the floorings to virgin soil.

Photographs of the rooms were taken from a 24-foot tower; those of the Great Kiva, from a 35-foot tower placed on a base 8 feet high (Plate X). A standard photograph of a 3-foot-square area of masonry was obtained for each room. This was accomplished by delineating the 3-foot area with chalk and by placing the camera lens each time 5 feet 4 inches distant from the wall-area. General photographs were taken upon frequent occasions. By recording the direction of each view, I secured pictures which have supplemented my notes very effectively. An Eastman 5 x 7 View Camera provided with a Zeiss Protar lens was used. All films were immediately developed in the camp darkroom cellar by Photographer Lloyd.

Mapping was done from time to time by Cartographer Burgh, who made a plan and four-elevation drawing (which records all measurements, openings, beam holes, and niches) for each room. A sample drawing is reproduced herewith (Fig. 3).

Leaning or bulging walls were braced with wooden supports. I had originally planned to cap the tops of all walls with cement. Lack of money, however, forced an abandonment of this plan. Wherever possible, therefore, the rooms were back-filled at the end of the season. Kiva B was back-filled almost immediately to preserve the mural decorations found therein (see Chapter III).

The skeletal material was not well preserved and therefore presented great difficulties in excavating. Trowels, whiskbrooms, small knives, orange sticks, camel's-hair brushes, and even a tire-pump were employed for cleaning and preparing the skeletal remains for photography.

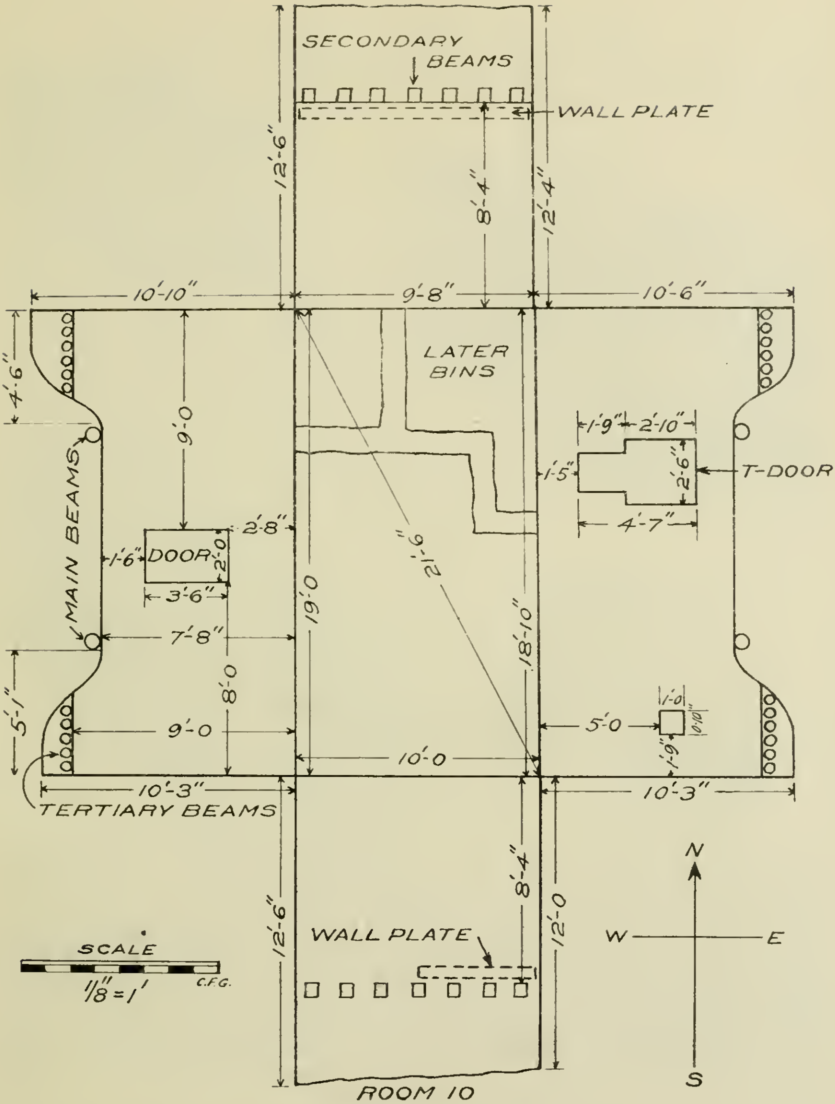


FIG. 3. Sample of plans and four-elevation drawings (Room 10 illustrated), showing method of mapping rooms.

II. DESCRIPTION OF PUEBLO DETAILS

(For general views of Pueblo, see Plates XI–XXI and Maps 1–3.)

Walls

FOUNDATIONS

Foundations extend from 4 to 18 inches below floor levels. They are either as wide as the walls proper or appear as projecting platforms or footings from 6 to 15 inches wider than the walls. Those belonging to primary or main walls are built of large, rough, undressed stones solidly laid; while those belonging to late and secondary walls are constructed of cut and uncut stones indifferently placed, and are bottomed on ash or other soft fill. In a few instances walls spring directly from the floor level with no bases whatsoever. In those places where substructures exist it is evident that they were intended to provide a solid base on which the walls might rest.

DIMENSIONS

	Feet	Inches
Thickness of walls		
Greatest width (Room 8)	3	0
Least width (secondary wall, Room 15)	0	4
Average width	1	9
Height of standing walls above floors		
Greatest height (south wall, Room 10)	12	6
Least height (south wall, Room 1)	1	1

CONSTRUCTION

Corners formed by two contemporaneously constructed cardinal walls (as opposed to partitions) are generally bonded. It should be noted that bonding might be present on both the inside and outside of a corner or on one angle only. It is generally assumed that bonding implies synchronal construction. However, at Lowry ruin I believe that I found two corners (the southwest corner of Room 26 and the northeast corner of Room 17) where earlier and later walls are bonded. Certainly, two types of masonry are united at these corners. Inbond or header stones are rare.

With the exception of one wall (southeast quarter of south wall of Room 16) which is a through stone wall, that is, a wall built entirely of stones which extend through the full thickness of the wall, all walls are built with a core and faced on both sides with surfaced stones. The hearting is composed of small, uncut stones, or rubble and copious amounts of adobe mortar.

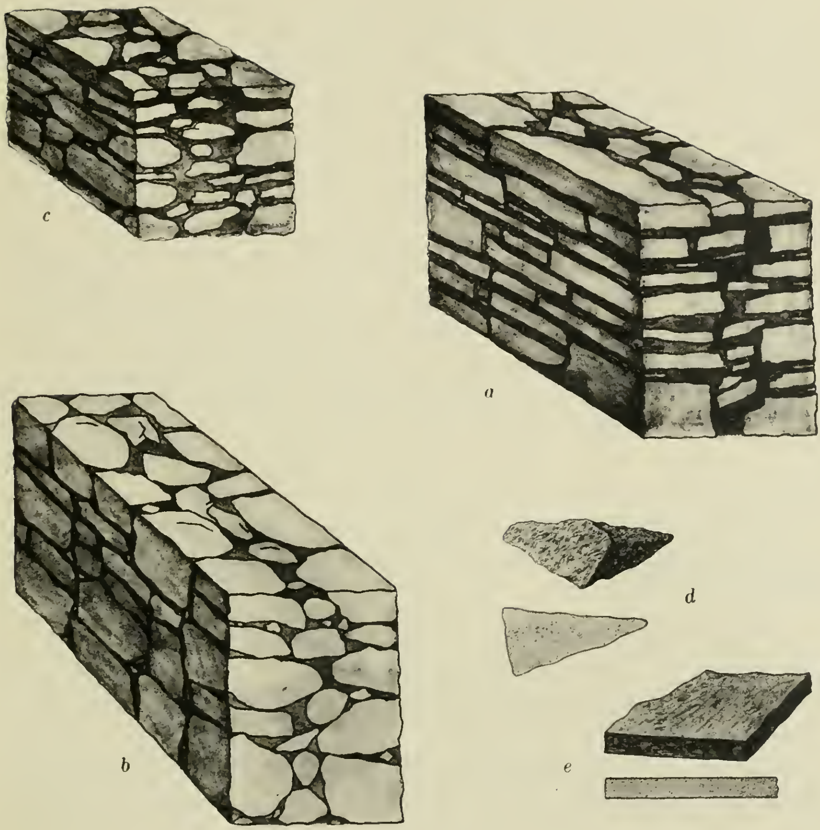


FIG. 4. Schematic drawings of masonry types and spalls prevalent at Lowry Pueblo and the different features of masonry technique shown by dissecting a wall. *a*, Essential points found in a Chaco-like wall. Note the mud cushions separating the stones and the spalls, the consistent use of "stop" spalls to hold back the mud mortar, and the natural tendency towards coursing. *b*, Non-Chaco or block-like technique in which the wall-load is transmitted downward mostly through the stone-to-stone contacts, the mud merely filling the voids. *c*, The technique that appears somewhat like both types *a* and *b*. Drawn to a larger scale, sketches *d* and *e* bring out the characteristics of the two kinds of spalls: *d* shows a "false" spall, which is wedge-shaped; *e* shows a "stop" spall which is flake-like.

TYPES OF MASONRY

After much discussion and study Mr. Roys and I have decided to divide the type of masonry at Lowry Pueblo into three large groups: Chaco-like, non-Chaco, and Intermediate (Fig. 4; see also Chapter VI for Mr. Roys' analysis of masonry).

The Chaco-like masonry is again subdivided into three classes for which it is difficult to find names. The earliest Chaco-like masonry at Lowry Pueblo as exemplified in the "nucleus" (Rooms 10, 15, 19, and 21) consists of rather thick slabs and thin, "stop" spalls laid up with a thin mud-cushion (Plates XXII, XXIII). The second class of Chaco-like masonry (found in Rooms 16 and 18) is made up of long, thin slabs, the edges of which have been flaked or chipped off (Plate XXIV). This same type of masonry also occurs at Pipe-Shrine House, Mesa Verde National Park. The third class of Chaco-like masonry (found in Rooms 26, 27, south wall of 7, and in Kivas B, D, and F) consists of long, very thin slabs and thin "stop" spalls laid up in a thick mud-cushion (Plates XXV, XXVI).

The non-Chaco type of masonry is constructed of block-like stones (as opposed to thin slabs) and true-bearing spalls (Plates XXVII, XXVIII).

The third type of masonry, which I have designated herein as "Intermediate" or "modified Chaco," embraces characteristics of both the Chaco-like and non-Chaco types of masonry (Plates XXIX–XXXI).

A complete description and discussion of these types of masonry follow in Chapter VI, which was written by Mr. Lawrence Roys.

MATERIALS USED

Stone used in the pueblo is of two kinds: (1) a well-laminated, hard, ferruginous Dakota Cretaceous sandstone varying in thickness from ½-inch to 4 inches; (2) a massive, block-like, soft calcareous, Dakota Cretaceous sandstone often occurring as blocks 6 inches high and 10 inches long. The laminated stones appear almost exclusively in the Chaco-like masonry (for example, Rooms 10, 15, 27, and Kiva B). Walls built of such ferruginous material are naturally dark brown. The block-like calcareous stones occur exclusively in the masonry of Rooms 1, 2, and 9 and are used in varying amounts in other rooms. These sandstones are found in the canyons which are immediately adjacent to the pueblo. The ferruginous, laminated sandstone occurs at the surface. No quarries were located.

SURFACES

As noted previously, both block-like and laminated stones were employed. The block-like stones appeared to have been hewn somewhat and their faces were often dimpled or rubbed. These "worked" stones, however, are very deceptive, for all the faces are fairly rough. It is, therefore, surprising that the walls look so well when they are composed of stones, the exposed faces of which are but little more shaped than the other sides.

Laminated stones were generally untooled and were used as they came from the quarry. Sometimes when re-used in later walls, their faces were dimpled, although this practice was not common because such ferruginous material is refractory and very hard. Sometimes, however, whole walls would be composed of laminated stones, the edges of which had been flaked or chipped. This same phenomenon occurs in some of the walls at Pipe Shrine House in Mesa Verde National Park.

JOINTS

Bed or horizontal joints vary in width from ¼ inch (between laminated stones) to 1½ inches (between block-like stones) and are either raked (intentional?) flush or beaded. I did not observe many broken joints.

SPALLS

Stone spalls were ordinarily employed, although a few sherd spalls were observed. The spalls fall into three classes:

(1) False spalls, which are roughly shaped like wedges, were inserted in the joints to swell the mud mortar against the adjoining wall stones and to keep the mud from cracking. These spalls usually did not touch the wall stones (Fig. 4, *d*).

(2) Stop spalls, which are always flat, thin, laminated pieces of stones, were inserted as the wall was laid up and are flush with the joints. Such spalls, together with the thin mud-cushions embedding them, served as dams or stops which prevented the interior layers of mud from being squeezed out when the wall was built (Fig. 4, *e*).

(3) True-bearing spalls, which are jagged stone fragments of irregular shape, were incorporated within the wall. These touch the stones above and below and transmit the pressure of the upper stones downward.

MORTAR

The color of the mortar is either gray or a pinkish red—the natural color of the local adobe. The mortar in rooms which had

burned is generally red and is very much harder than that which occurs in unburned rooms. As a rule, however, all mortar was surprisingly tough and firm. No grog or "tempering" was observed.

PLASTER

Mud plaster occurs on the wall of only one room. It is not possible to state whether any other rooms were plastered or not. External plaster was not noted.

APPEARANCE

Pronounced coursing is evident in those walls constructed of laminated or tabular sandstone; it is not so well-defined in walls composed of block-like stones. The neatest and most pleasing walls are those built of laminated stones.

DOORS

	T-Doors		Rectangular Doors	
Total number in pueblo	7		9	
Largest door	Feet	Inches	Feet	Inches
Height	7	0	5	2
Top width	3	9	2	4
Base width	1	10	2	4
Smallest door				
Height	4	3	3	5
Top width	2	3	2	3
Base width	1	8	2	3

The largest T-door is in the west wall of Room 9 (Plate XXXII); the smallest, in the east wall of Room 27. The largest rectangular door is in the east wall of Room 8 (Plate XXXIII); the smallest, in the west wall of Room 15 (Plate XXXIV).

The greatest distance between sill and floor is 3 feet 8 inches (Room 10); the least distance is 5 inches (Room 9); the usual distance is about 20 inches.

Most doorways are centered in the side or end walls of the rooms; but in Room 15 (north end of east wall, second story) an entrance is located at one end of the side wall at the corner.

No corner doorways cut diagonally (such as are found at Pueblo Bonito) exist, although in the southeast corner of the second story of Room 6 and in the southeast corner of the first story of Room 20 there is a marked and peculiar diagonal bonding of the masonry, which protrudes four or five inches from the corner and which closely resembles a sealed corner-doorway. There is no sign of a doorway, however, on the other sides of these corners. These peculiar diagonal bondings may possibly be vestigial corner doorways, with which the builders may have been familiar (Plate XXXV).

All doorways but two had been provided with both stone and wooden lintels. The wooden lintels consist of three to five small poles about 2 inches in diameter (Plate XXXIV).

VENTILATOR OPENINGS AND CUPBOARDS

There are eleven ventilator openings in the pueblo, the largest of which is 1 foot 6 inches square (Room 8), and the smallest, 1 foot square (Room 10). The sills are usually about 6 feet above the floor. These openings are provided with both stone and pole lintels. The location and number of these openings per room do not seem to follow any order. Some of them are near doors, while others are not; some rooms have several, while others have none. All of them are near the ceiling; none are near the floor. It is possible that a few of these apertures served as beam sockets, but it is not likely, for all of them are rectangular and are roofed with stone as well as pole lintels.

WALL PLATES

Wall plates are horizontal beams laid in walls to carry the ends of other timbers. Fragments of such log plates were found in a few places (north and south ends of Room 10 and north wall of Room 15; Plate XXXVI). These timbers, which measure 7 or 8 inches in diameter and which were built in the rubble core, shared with the wall-facing the task of carrying the ends of the rafters or joists. This was a departure from the customary roofing technique. Wall plates are not ordinarily found and beam ends seem usually to rest either in sockets in the wall face or on posts. Wall plates also occur in Pueblo Bonito, in Cliff Palace, and in Far View House.

RECESSED OR BUILT-IN POST

A single recess or vertical channel occurs in the north wall of Room 13. This recess may be described as a vertical slot 6 inches wide and 5 inches deep. In it were the rotted fragments of a built-in post, the exposed face of which was flush with the inside face of the wall. The post may have supported one end of the principal roof beam. The reason for recessing this particular post and not others, which probably served also as roof supports, is unknown.

FLOORS

MATERIAL

The floors are all composed of adobe, from 1 to 3 inches thick, which had been laid wet, packed hard, and rubbed smooth and level.

Room 18 (a late addition built on top of the debris in Kiva D) was paved with stone slabs. These slabs varied in thickness from ½ to 2 inches, in length from 6 to 17 inches, and in width from 5 to 11 inches.

ALTERATIONS

In general, the original floors stood without any changes. A few floors were resurfaced four or five times by spreading additional coatings of adobe. There is no method of telling how much time elapsed between these renovations. Three floor-levels in Room 32 were uncovered. The second level was 18 inches above the first; the third, 20 inches above the second.

BINS

Six storage bins occur. Their sides are constructed of stones which are faced on the inner surface and unfaced on the outer, and their floors, of tightly laid stone slabs. All of them had been built in late times on 3 or 4 feet of debris within already abandoned rooms (Plate XXXVII). The dimensions of the bins vary; the smallest measures roughly 2 feet by 2 feet and is 7 feet deep; the largest, about 4 feet by 7 feet. Entrance to the bin in Room 10 was gained by means of a T-doorway which had formerly served Room 10 (Plate XXXVIII). Corncobs, burned corn, and burned beans were recovered from the bin in Room 11.

No grinding bins were found.

FIREPITS

Firepits are found in only three rooms; namely, 13, 32, and 35. The firepit belonging to Room 13 is terraced, the lower level being slab-lined and measuring 2 feet in width, 2 feet 7 inches in length, and 2 feet 5 inches in depth (Plate XXXIX). Large pieces of sagebrush and juniper charcoal were recovered from the lower level. The firepit in Room 32 was merely a small hollow in the floor in which were found a few ashes. Room 35 possesses two firepits: "A" has a slab floor and slab sides, and is 3 feet wide, 3 feet 7 inches long, and 1 foot 10 inches deep; the other, "B," has sides of masonry and slabs and an earthen floor and measures the same as the former, except that it is only 1 foot deep (Plates XL, XLI). No soot was noticed on any of the walls of any of these rooms.

POTTERY AND ARTIFACTS IN SITU

Potsherds were recovered from the fill and from the floors of all rooms. Complete or mendable pieces of pottery were obtained from

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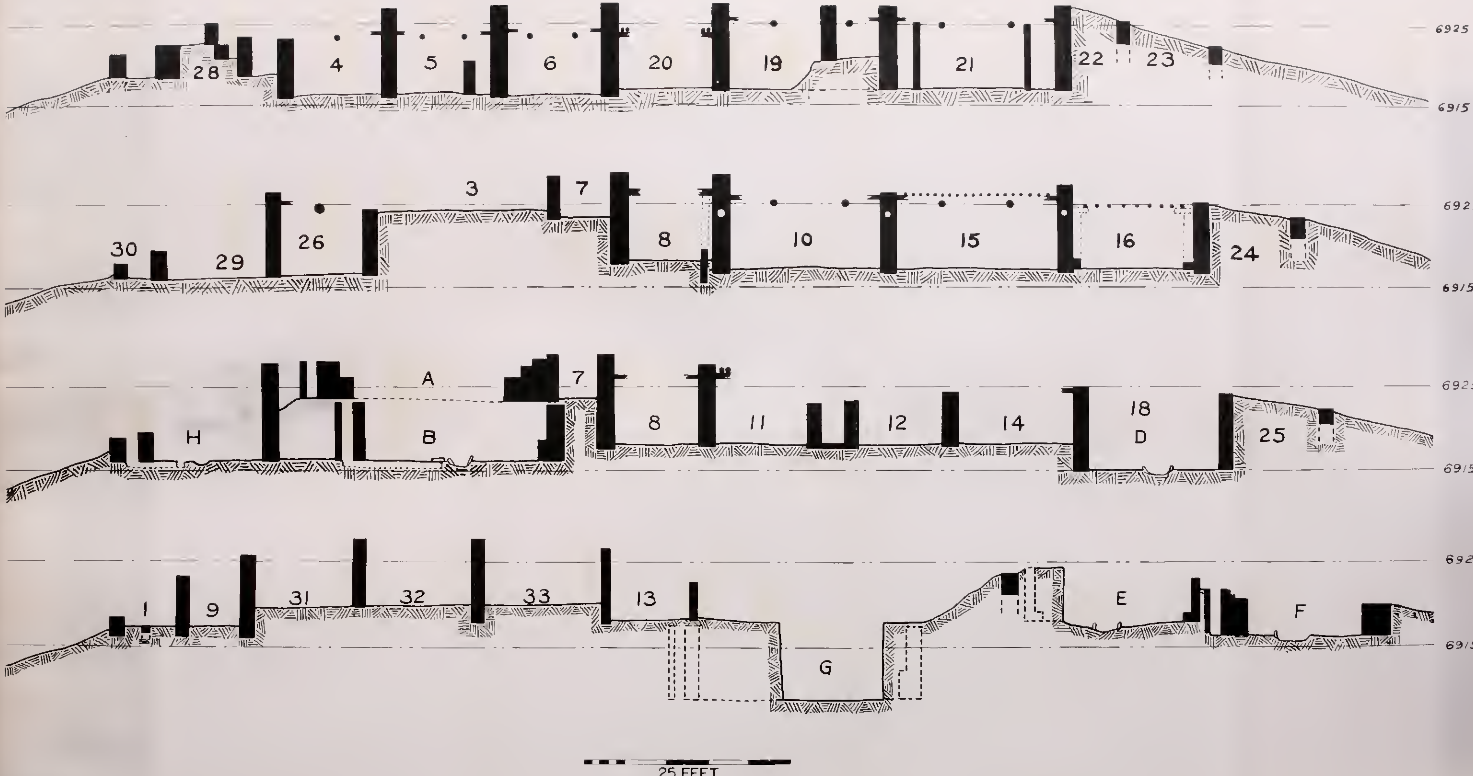


Map 3. CROSS SECTIONS OF LOWRY PUEBLO

the floors of Rooms 8, 9, 10, and 16; from second-story debris in Rooms 4, 8, 16, and 19; from the northwest bin in Room 10; from the passageway between Rooms 11 and 12; and from graves.

A few stone artifacts, such as projectile points and axes were found in the room fill, but rarely on the floors. Metates and manos were discovered on the floors of Rooms 11, 13, 15, 16, and 18.

Bone artifacts were recovered in refuse heaps, in room debris, and on the floors.

All of these materials are fully discussed and described in Chapter IV.

CEILINGS

HEIGHT

The height of the main-beam sockets above the floor, as measured from floor to base of socket, varies from 6 feet 8 inches (Room 11) to 8 feet 6 inches (Room 5). The sockets for the secondary beams, as measured from floor to base of socket, vary in height from 7 feet 4 inches (Room 4) to 9 feet 2 inches (Room 27).

TYPES

There are five types of ceiling construction to be noted at Lowry ruin.

Type 1 (as found in Rooms 10 and 15):

(*a*) Two socketed main beams from 9 to 12 inches in diameter which crossed the narrow way of the room. They were so spaced as to divide the length of the room into thirds.

(*b*) From 7 to 9 socketed beams which spanned the length of the room and which measured from 5 to 8 inches in diameter.

(*c*) From 20 to 25 small, socketed poles, 2 to 3 inches in diameter, which crossed the short span of the room. In addition to being socketed, the ends of these poles were also supported by means of a step-back in the wall (Plates XLII, XLIII).

(*d*) Wooden slabs or splints laid crisscross and tightly together on top of these three layers of beams.

(*e*) Cedar-bark and, finally, several inches of adobe, which formed the floors of the second-story rooms.

The overall thickness of such a ceiling would be about 18 inches.

Type 2 (as found in Rooms 4 and 26):

This type is much the same as type 1, except that there was only one large main beam instead of two.

Type 3 (as found in Rooms 7 and 8):

(*a*) No large main beams, but several smaller poles, 4 to 6 inches in diameter, which extended across the short span of the room. These were socketed about 2 feet apart.

(*b*) Wooden slabs or splints laid tightly together across the stringers.

(*c*) A covering of cedar-bark and, finally, several inches of adobe.

Type 4 (as found in Rooms 12 and 14):

(*a*) From 2 to 4 principal large roof beams supported at one end by vertical posts set in floor and, at the other end, either by vertical posts set in floor or by beam sockets.

(*b*) Poles laid closely together at right angles to main beams.

(*c*) Wooden slabs or splints packed closely together and laid in both directions.

(*d*) A covering of cedar-bark and adobe.

Type 5 (as found in Room 16):

(*a*) Two large principal beams which were not socketed, but which were supported at the ends by means of four stone pillars. These pillars were 24 inches wide, projected 18 inches, and stood 7 feet 8 inches high.

(*b*) Six or seven stringers placed in sockets spaced about 2 to 2½ feet apart and set at right angles to principal beams.

(*c*) From 30 to 40 small poles placed close to one another at right angles to the stringers.

(*d*) Wooden slabs or splints laid tightly together and at right angles to the small poles.

(*e*) A layer of cedar-bark and several inches of adobe.

DESCRIPTION OF BEAMS

The largest beams were of yellow pine and measured 14 inches in diameter. Secondary beams were found to be yellow pine, juniper, and pinyon, and varied in diameter from 3 to 6 inches. The ends of all the beams were bluntly conical as if gnawed off by beavers.

SECONDARY OR EXTRA VERTICAL SUPPORTS

Extra vertical roof supports, consisting of wooden posts from 6 to 10 inches in diameter, were observed in Rooms 8, 11, 13 (two posts), 19, 21, 26, and 35. These posts were placed in the center of the room (Room 26), or in front of a doorway (Rooms 19 and 21),

or near a wall (Room 11), or were set in a recess in a wall (north wall, Room 13). I cannot determine whether these extra roof supports were set when the roof was constructed or whether they were placed at a later date to prevent a weak roof from collapsing (Plate XXXIX).

GENERAL (ARRANGEMENT OF PARTS)

NUMBER OF ROOMS

The pueblo is composed of at least 37 ground-floor rooms. Of this number all were excavated except Rooms 22, 23, 24, and 25. I feel fairly certain that further digging would disclose more rooms and that the total number of ground-floor rooms might run as high as 50.

USE OF ROOMS

It is impossible to state with any certainty for what purposes these rooms were used. I believe that those rooms having ground-floor doorways served as living quarters (Rooms 9, 10, 11, 12, 13, 14, 19, 21, and 27). It seems likely that those ground-floor rooms without lateral doorways were entered by means of hatchways or trap doors in the roofs and that they may have been used as storage chambers (Rooms 1, 2, 4, 16, 17, 20, 26, 31, 32, 33, 36, and 37).

Room 16 is without lateral doorways or ventilators and had probably served as a granary, for in it were found a great quantity of burned, shelled corn and three metates with end-to-end troughs.

Rooms 34 and 35 were apparently left open towards the east. The side walls are neatly finished at the ends and no vestige of a cross wall on the east side was discovered. Room 35 contains two fire-pits and it therefore may have served as a "summer-kitchen." I have no guess as to why these two particular rooms were constructed in such fashion. No others of this type were uncovered.

Room 3 is not a room in the strict sense of the word, but is merely the enclosure resulting from the construction of Kiva B within a rectangular area. The filling material in this space was a very soft dirt mixed with ashes and charcoal and was evidently intentionally placed there by the builders.

NUMBER OF STORIES

I believe that no part of Lowry Pueblo was ever more than three stories high. This conclusion was arrived at in the following manner.

It is probable that the roof timbers gradually rotted and then collapsed in the middle where the strain was greatest. The wall above the beam ends then would have been pried up somewhat and probably the inner facing and some of the core would tumble down within the room. It seems reasonable, then, to assume that about half of the wall would fall inside the room and half, outside.

Therefore, by computing the cubic content of the fallen mud mortar and stone within a room (exclusive of wind-blown material) and then by estimating how many running feet of wall could be constructed from this mass (if it were re-used without waste) it is possible to reckon how much higher a given wall may once have stood.

For example, let us take Room 10, which measures 10 by 19 feet inside. The walls are 2 feet thick and now stand 12 feet 6 inches high; the debris (fallen stones, etc.) within the room was found to be 4 feet in depth. The volume of debris is obviously $10 \times 19 \times 4$ or 760 cubic feet. This same volume in the form of a standing wall would be the area of horizontal cross section multiplied by the height. The former is simply the effective perimeter of the wall (58 feet inside plus a foot for each corner) or 62 feet multiplied by the thickness of that part of the wall falling inward, which is 1 foot (one-half of the wall thickness of 2 feet) or an area of 62 square feet. The height of the fallen portion of the wall would be derived by dividing 760 cubic feet by 62 square feet or 12¼ feet in vertical dimension. By adding this 12¼ feet of height of fallen wall to the 12 feet 6 inches now standing, the total height of the original wall is obtained, in this case 24¾ feet. This distance of approximately 25 feet would easily provide space for three stories of about 8 feet each, but would not provide for a fourth story.

This is a rough method for calculating the probable height of fallen walls, but is as accurate as the data warrant. Color, however, is lent this idea by the fact that at present there still remain 1½ to 5 feet of wall above the ceiling levels of the rooms which I believe were variously of two or more stories. Unless there were a roof parapet, this masonry would have been superfluous; and I have been unable to find any record of parapets in pueblo architecture. Moreover, the stone debris within each room is undoubtedly constituted of collapsed walls.

Therefore, I think it is reasonable to assume that for these reasons Rooms 4, 5, 6, 8, 9, 10, 15, 16, 17, 19, 20, 21, 26, and 27 were at one time three or possibly two stories high. And conversely, because of the lack of much stone debris or of walls standing above

ceiling levels, all the other rooms were only one or two stories in height.

ALTERATIONS

Lowry Pueblo as it stands today does not represent a homogeneous unit built at one time. It is, rather, a heterogeneous conglomeration of rooms erected at intervals during the course of many years. There is evidence for believing that the site may have been abandoned from time to time and then reoccupied. It is inevitable that these cycles of habitation and desertion should have wrought great changes.

It is not surprising, therefore, to find partially destroyed walls which once formed sides of rooms and which were later torn out or on which new walls were erected. Nor does it seem unnatural to discover new rooms added haphazardly; to come upon sealed doorways and flimsy partitions; and to note many other alterations. Rooms 10, 15, 19, and 21, which form the "nucleus" of the pueblo and which were all built at one time, are probably the only ones which remained more or less intact during the various changes. But even these rooms were constructed on top of older house walls, and were later modified by newcomers.

The square now containing Kivas A and B as well as Rooms 3, 7, 17, 26, and 27 included at one time a kiva of unknown size (the vestiges of this kiva may be observed on the wall just south of the ventilator shaft of Kiva A; see ground plan, Map 2) and several rooms, also of unknown sizes. At a later date, this kiva and some of the rooms just referred to were wrecked and Kiva B (lower kiva) was constructed in that same area. At the same time, Room 7 was formed by adding a south cross wall. The east and west ends of this wall abutted partitions already in existence. The fourth side was the south wall of Room 8.

After a time, Kiva B fell into decay and became partially filled with wind-blown dust particles which rains and snows cemented together. Following this, the inhabitants of the pueblo filled up the remainder of Kiva B and erected a slightly larger one, Kiva A, over the older one.

It seems certain that Kiva A was altered from time to time. Because the walls were bottomed on soft fill, they slumped. It then became necessary to add a secondary supporting wall in the north quadrant and to erect posts to prevent the supporting wall from slipping out of place. The ventilator tunnel was likewise changed in Kiva A. Originally it had been the sub-floor type. At

a later date, it was reconstructed so that the tunnel opening was above the floor and was flush with the wall of the southern recess.

Room 18 also underwent several changes. It first served as an ordinary, secular room and was somewhat smaller than it now is. The roof of that room burned. The room was then enlarged by adding a short span of wall on the north and south sides and a kiva (Kiva D; Fig. 5) was inserted in this space. The enlargement of this room may be seen on the ground plans by observing the additions of walls at the west ends of the north and south walls of Room 18 (Plate XLIV). Later, the kiva roof burned and then the upper part of that space was used as house-room, the floor of which was composed of slabs.

SEALED DOORWAYS

Sealed doorways occur in secular rooms which surround a kiva incorporated within the pueblo building (as in the case of Kivas A and B). The doorways of such secular rooms were blocked up with masonry seals and the rooms were then filled completely with dirt and refuse. Consequently, the kiva could technically be considered subterranean, and thus was orthodoxy satisfied. Sealed doorways may be noted in Rooms 5, 6, 7, 8, 9, and 27 (see ground plan, Map 2; Plate XLV).

BONDED CORNERS

When two walls are bonded at a corner, archaeologists generally conclude that such walls were built simultaneously. At Lowry ruin, however, there is clear evidence for believing that such an assumption is not always justified. In the southwest and northeast corners of Room 26 and in the northeast corner of Room 17, bondings of two indubitably different types of masonry occur. These articulations, when closely scrutinized, are not clear-cut vertical joints, but are jagged, irregular, and sloping. It seems quite apparent, then, that a segment of an older wall of unknown length had been torn out and that a new bit of dissimilar masonry had been spliced to the old in much the same manner as a weaver would skillfully introduce into a torn textile new strands of weft.

This practice of tying a new wall to an old one may not be uncommon; but so little attention has been paid to masonry by archaeologists that I am unable to judge how common the practice is. In the report on Pueblo Bonito (Pepper, 1920, pp. 17 and 388–389) mention of new walls being spliced or joined to old ones, is made. Judd (1928, p. 72; Plate III, Fig. 2) refers to the junction

of second- and fourth-period walls as an abutment. Judged solely from the plate which appears with this reference this junction appears to be a bond and not an abutment.

SECONDARY WALLS

Crudely built, secondary walls occurred in Rooms 5, 12, 14, 19, 21, 26, 27, 28, 31, and Kiva A (Plate XLVI). Such walls were bottomed on debris, were thin, and were flung up for the purpose of subdividing large rooms into smaller ones.

Miscellaneous Notes

The only burned roof which was found was in Room 16.

The debris within the rooms, excluding that made up of fallen walls, was of two kinds: artificial or man-made fill which was very soft and ashy (Rooms 3, 4, 5, 6, 7, 9, 17, 21, 26, 27, 28, 29, 30, 31, 32, and 33); and natural or wind-blown fill, which was always hard and which contained few if any sherds. The fill in Room 8 was composed mostly of ash of which there were about 2,500 cubic feet. Mixed with the ash were thousands of potsherds from which an excellent stratigraphic sequence of pottery was obtained.

III. DESCRIPTION OF KIVA DETAILS

Small Kivas

(See page 44 for table of details.)

NUMBER OF KIVAS

Eight small kivas were excavated at Lowry Pueblo. These are lettered on the ground plan from A to H inclusive (Maps 2, 3; Figs. 5–7; Plates XLVII–L).

POSITION IN PUEBLO

Kivas A, B, D, and H are incorporated within the building; Kivas E and F adjoin the pueblo; and Kivas C and G are detached. The floor of Kiva C lies 7 feet below ground; that of Kiva G, 10 feet. Kivas B, D, F, and H were built at ground level. Kiva A was constructed over an earlier kiva (B) (Fig. 6; Plate LI) and Kiva E, on ashy fill.

The exterior wall of Kiva F is smooth-faced—an unusual occurrence. It is possible that this kiva stood in the open.

MASONRY

The masonry of the kivas is much the same as that found in the houses. Some of it is excellent; some of it is inferior (Plates LII–LV). The description of the masonry of the pueblo as given in chapters I, II, and VI also applies to that of the kivas. In the table below (p. 44), the classification of masonry of the various kivas is given. Kiva walls were erected without any foundations.

ROOFS

There is no doubt that all the small kivas, except Kiva F, were roofed by means of short beams laid crisscross, the first set resting on the pilasters. Cribwork roofing of this type was common in the area (Kidder, 1924, p. 60).

The system of roofing Kiva F is not precisely known. In lieu of the orthodox pilasters of masonry, six wooden posts had been substituted. These posts had measured 7 inches in diameter, had been placed in the ground about a foot, had been set out from the wall 6 to 8 inches, and had been held upright by means of stones placed about the edges of the post-holes (Plate LVI). There is no evidence of any banquette in this kiva. The upper ends of

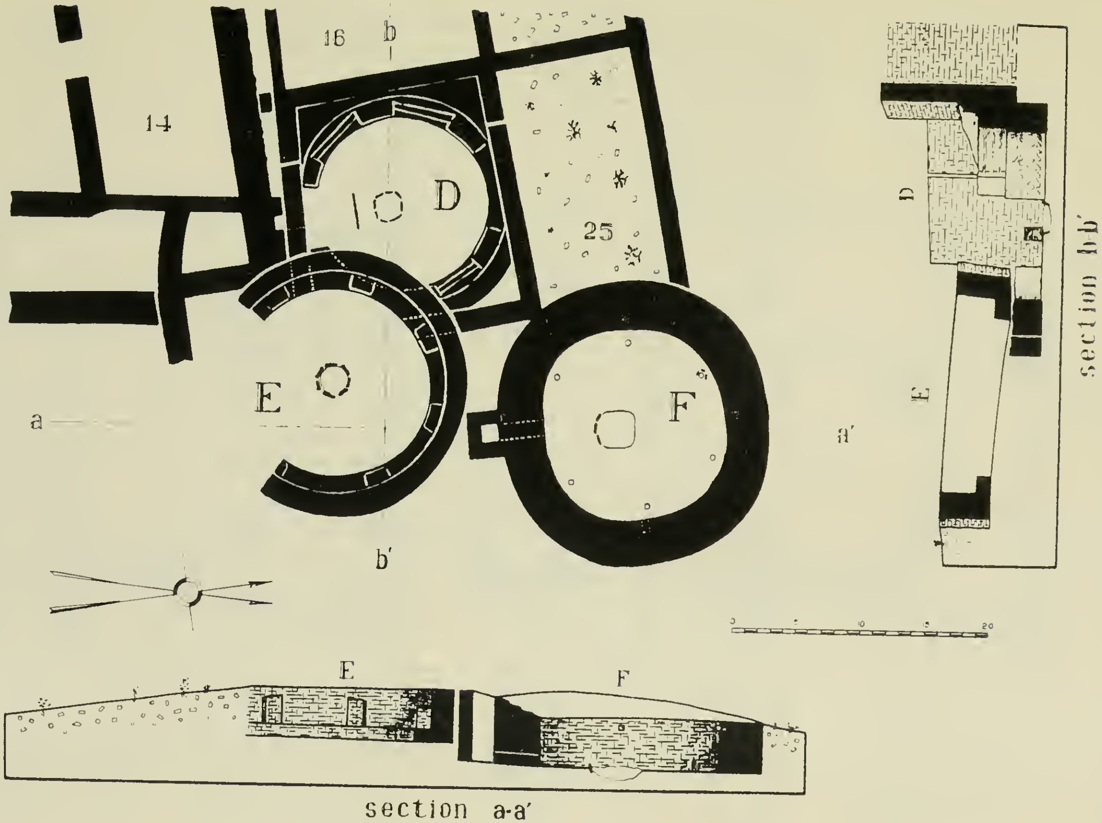


FIG. 5. Detail plan and sections of Room 18 (Kiva D) and Kivas E and F.

these upright posts may have been forked, thus providing a rest for the large roof beams.

VAULTS

Kiva C is the only small kiva containing a subfloor vault. It is located on the west side of the fireplace (Plate LVII). This vault is not masonry-lined, but is merely a pit which measures 6 feet 6 inches long, 2 feet wide, and 1 foot 5 inches deep. The debris within it was the same as that found on the kiva floor; namely, wind-deposited dust and some refuse.

SHELVES

In Kivas B and D inter-pilaster shelves occur (Map 2; Plates LVIII, LIX). These shelves span the inter-pilaster recesses (except the southern recess) and consist of trios of poles, the ends of which are built into the sides of the pilasters. The upper surfaces of each set had been smoothly plastered with mud. The distance between each set is about a foot and there are three sets to each recess.

Shelves such as these probably occur at other sites, although I have been unable to find any reference to them. Mr. Burgh informs me that he has observed them in kivas at Oak Tree House and Painted Kiva House, Mesa Verde National Park.

MURAL DECORATIONS

Painted designs were discovered on the banquette faces of Kivas A, B, D, and H (Plates LIX–LXIV). Two different types of decoration were uncovered in Kiva A; one type consisted of vertical, black stripes with white dots at the upper ends; and the other, of a terraced design done in white on brown mud-plaster. Both of these design units were continuously repeated all the way around the banquette face. Also in Kiva A the face of the deflector towards the fireplace was decorated with a geometric design.

The paintings in Kivas B, D, and H are likewise made up of terraced designs.

The composition of the paints used in these murals is not known. My guess is that the black paint was probably similar in content to that used in decorating pottery, and the white paint was probably made from gypsum. These pigments were applied to the adobe plaster.

Paintings in kivas are fairly common, although it is unusual to find any paintings so well preserved in an open site as they were in Kiva B. Roberts (1932, pp. 78–80) mentions several sites in which painted rooms have been found.

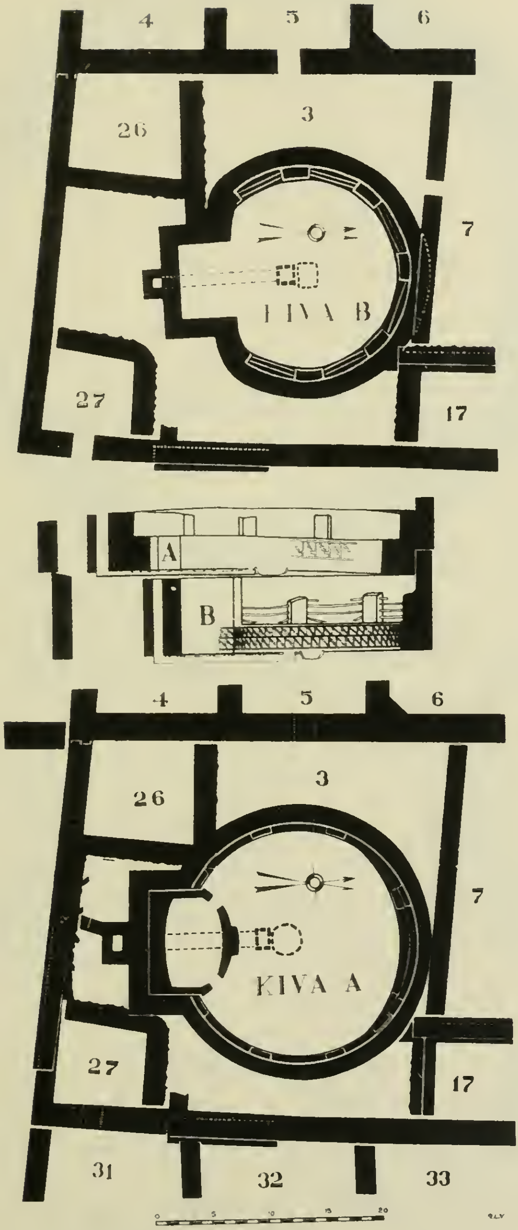


FIG. 6. Detail plans and sections of Kivas A and B.

VARIOUS KIVA DETAILS

	Kiva A	Kiva B	Kiva C	Kiva D	Kiva E	Kiva F	Kiva G	Kiva H
Greatest inside diameter (above bench)	21′ 0″	19′ 0″	16′ 6″	16′ 6″	17′ 4″	14′ 8″	22′ ?	*c.*12′
Height of kiva wall	6′ 0″	7′ 6″	6′ 6″	9′ 0″	4′ 4″	5′ 0″	10′ 0″	4′ 0″
Thickness of kiva wall	1′ 6″	2′ 0″	1′ 8″	1′ 6″	1′ 6″	3′ 7″	2′ 0″	2′ 0″
Bench:								
Depth	1′ 2″	1′ 3″	1′ 0″	1′ 6″	1′ 2″	....	1′ 6″	....
Height	3′ 4″	2′ 7″	2′ 6″	3′ 0″	1′ 1″	....	3′ 6″	....
Southern recess:								
Depth	5′ 0″	4′ 8″	3′ 0″	1′ 0″	?	....	?	....
Width	8′ 0″	6′ 8″	6′ 6″	4′ 6″	?	....	?	....
Height above floor	0′ 0″	0′ 0″	2′ 6″	0′ 0″	?	....	?	....
Pilasters:								
Number	8	7	6(?)	6(?)	6(?)	....	?	6
Depth	1′ 2″	0′ 11″	1′ 0″	1′ 6″	1′ 0″	....	2′ 0″	1′ 0″
Width	1′ 8″	1′ 11″	2′ 0″	1′ 6″	1′ 1″	....	1′ 0″	1′ 3″
Present height	2′ 0″	4′ 4″	3′ 7″	2′ 0″	2′ 0″	....	1′ 0″	2′ 0″
Chordal distance between	5′ 0″	5′ 0″	6′ 0″	4′ 6″	4′ 8″	....	7′ 6″	3′ 6″
Estimated roof height (above floor)	7′ 0″	8′ 7″	7′ 0″	6′ 0″	6′ 0″	7′ 0″	10′ 0″	6′ 0″
Floor	adobe	adobe	adobe	adobe	adobe	adobe	adobe	adobe
Fireplace:								
Diameter	2′ 5″	2′ 6″	3′ 0″	2′ 0″	2′ 0″	3′ 0″	?	2′ 0″
Depth	1′ 0″	0′ 8″	0′ 6″	0′ 6″	0′ 6″	0′ 8″	?	0′ 6″
Type of lining	adobe	adobe	adobe	adobe	adobe	adobe		adobe
Type of coping	....	stone	adobe	adobe	stone	adobe	?	slabs
Deflector:								
Type	mas'y	....	....	slab?	?	slab	?	....
Thickness	1′ 0″	....	....	?	?	0′ 1″	?	....
Width	2′ 6″	....	....	?	?	3′ 0″	?	....
Height	1′ 10″	....	....	?	?	1′ 6″	?	....
Ventilator:								
Type	sub-floor & lateral	sub-floor	lateral	lateral	?	lateral	?	sub-floor
Size interior inlet	1′ 0″ x 2′ 0″	1′ 7″ x 1′ 7″	1′ 4″ x 1′ 6″	1′ 6″ x 1′ 0″	?	1′ 5″ x 1′ 8″	?	1′ 6″ x 1′ 0″
Sipapu:								
Diameter	....	....	0′ 3″	?	?	?	?	?
Depth	....	....	0′ 5″	?	?	?	?	?
Niches:								
Number	....	2	....	1	?	3	?	2
Average depth	....	0′ 9″	....	0′ 6″	?	0′ 8″	?	1′ 0″
Average width	....	0′ 5″	....	0′ 5″	?	0′ 7″	?	2′ 6″
Average height	....	0′ 5″	....	0′ 4″	?	0′ 4½″	?	1′ 0″
Plaster:								
Number of coats	25	8	....	4	....	....	....	10
Thickness	0′ 5″	0′ 2½″	....	0′ 1″	....	....	....	0′ 3″
Color	brown	brown	....	brown	....	....	....	brown
Type of masonry	Chaco	Chaco	non-Chaco	Chaco	non-Chaco	Chaco	Chaco	non-Chaco

Note: Kivas E and G not completely excavated; mouth of sipapu of Kiva C filled with jar neck.

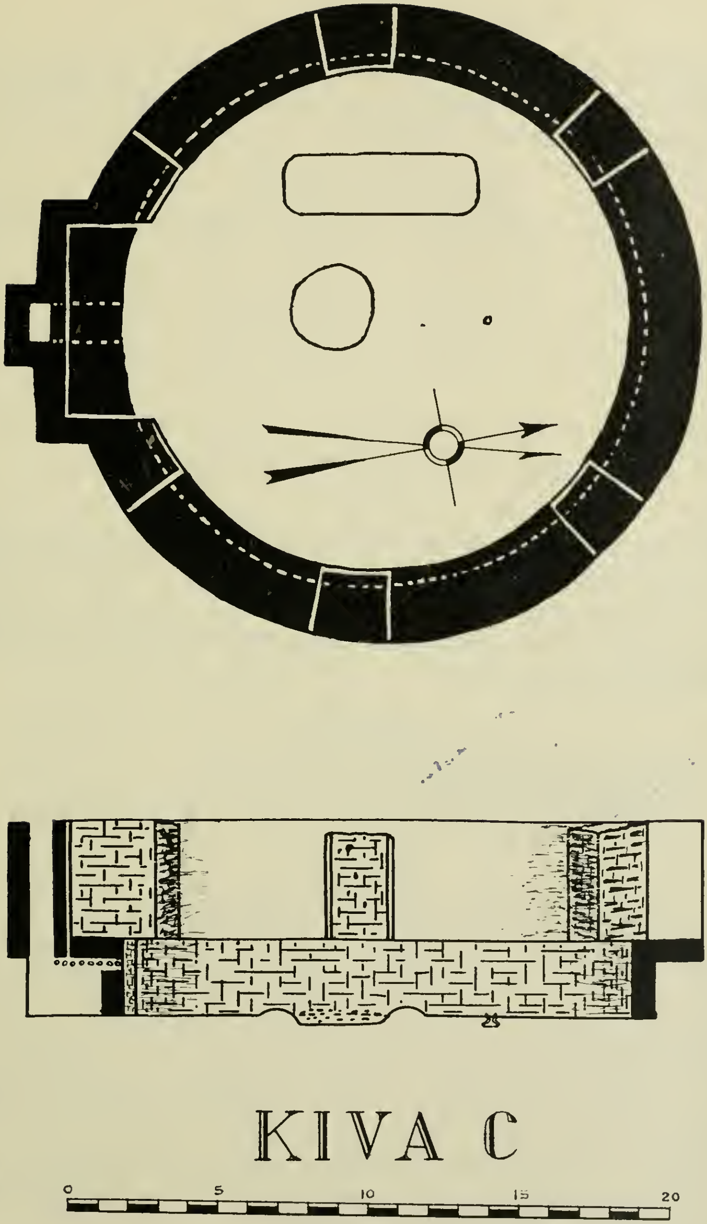


FIG. 7. Detail plan and section of Kiva C.

ENTRANCES

Entrance to these kivas was probably gained by means of a smoke-hole which was usually placed in the center of the roof. No special entryways were observed.

CEREMONIAL DEPOSITS

No ceremonial deposits of shell or turquois were found in any of the kivas.

THE GREAT KIVA

(Plates LXV–LXXII)

POSITION

The center of the Great Kiva at Lowry Pueblo lies approximately 200 feet east of the east wall of Room 36.

THE FILL

The fill was 4 feet deep in the central part of the Great Kiva and 7 feet deep in the outer zone. The upper portion of the fill was composed of rocks and wind-blown dust and was very hard. Near the floor-level large masses of burned roof beams and some potsherds were encountered.

DIMENSIONS

	Feet
Greatest inside diameter (above bench)	47
Present height of kiva wall (above central floor)	8
Thickness of kiva wall	1½
Depth of central floor below ground level	6

MASONRY

The masonry is similar to that of Rooms 16 and 18. Most of the rocks are slabs, the edges of which have been chipped and flaked. Chinking and spalling are rare, although I observed three small areas where chinking and false spalls occur (as in Lowry Intermediate masonry) and two small places where Chaco-like flat, "stop" spalls may be observed. The individual stones, for the most part, are crude and untooled. Even irregular stones and rounded boulders are to be seen. Some of the better blocks measure 9 by 10 inches. The slabs measure about 2 inches in thickness and 11 to 14 inches in length. By actual count, the wall contains 66⅔ per cent slabs and 33⅓ per cent blocks.

Although the walls now stand only 8 feet high, it is probable that they may have been from 4 to 6 feet higher, since the debris in the outer zone contained many wall stones.

FLOOR

The floor, which is of hard-packed adobe, consists of a central portion (*i*) and two terraces (*h*). The terraces are situated in the east and west segments of the kiva and lie between the sub-floor vaults (*d*) and low walls of masonry (*e*) and the kiva bench (*b*) (Map 4; Plate LXVI). These terraces (*h*) are 2 feet higher than the central floor (*i*). The low walls (*e*) on the east and west sides of the kiva which serve as retaining walls for the terraces consist of five courses of masonry. Each of them surrounds two pillar bases and a vault. Jutting out from each of the four pillar bases are other low, thin walls (*g*) which extend to the bench (*b*), thereby forming irregularly shaped enclosures (*j*).

ROOF

The four pillar bases (*c*) which are symmetrically placed about equidistantly from the bench, consist of alternate courses of juniper poles and masonry. Similar construction was discovered at Aztec (Morris, 1928, p. 117) and at the Village of the Great Kivas (Roberts, 1932, p. 87).

The dimensions of the pillar bases are:

Northwest and northeast pillar bases	3′ 0″ x 3′ 3″
Southwest and southeast pillar bases	2′ 11″ x 3′ 2″

All four bases rise 2 feet 6 inches above the level of the central floor. Since all of them are of the same height and since they are all flat, smooth, and well-finished on top, it seems likely that these pillar bases were never built up any higher than they now are. If this assumption be correct, it is then necessary to suppose that large posts, which supported the roof, stood atop these bases. I did not have an opportunity to dig beneath these bases to see if they rest on large, circular stone disks, such as were exposed at Aztec and at Chetro Ketl, New Mexico.

As stated previously, these bases are surrounded by low, secondary(?) walls, which serve as facings for the two terraces. It is possible that these walls also had other functions, which are not now understood.

If one may judge from the position in which the burned roof beams lay on the floor, it seems probable that the plan and construction of the roof of this Great Kiva were practically the same as that described and figured by Morris for Aztec Ruin (Morris, 1928, pp. 128–129).

I do not know, however, whether the roof was flat or vaulted; nor can I guess at its former height. It is possible that (1) the kiva roof

was only as high as the kiva wall (about 8 feet) and that the peripheral rooms (see page 51) were separately roofed; or that, (2) the kiva roof was high enough (approximately 15 feet) to include under one cover both the Great Kiva proper and the peripheral rooms. I believe that the former possibility is the more probable, but this is only a guess.

There is no doubt in my mind that the central part of the Great Kiva, as well as the bench-terrace zones, was roofed, for as many burned roof timbers were recovered from the debris of the central portion of the kiva as from that of the outer zone.

PEG(?) OR BEAM(?) SOCKETS IN KIVA WALL

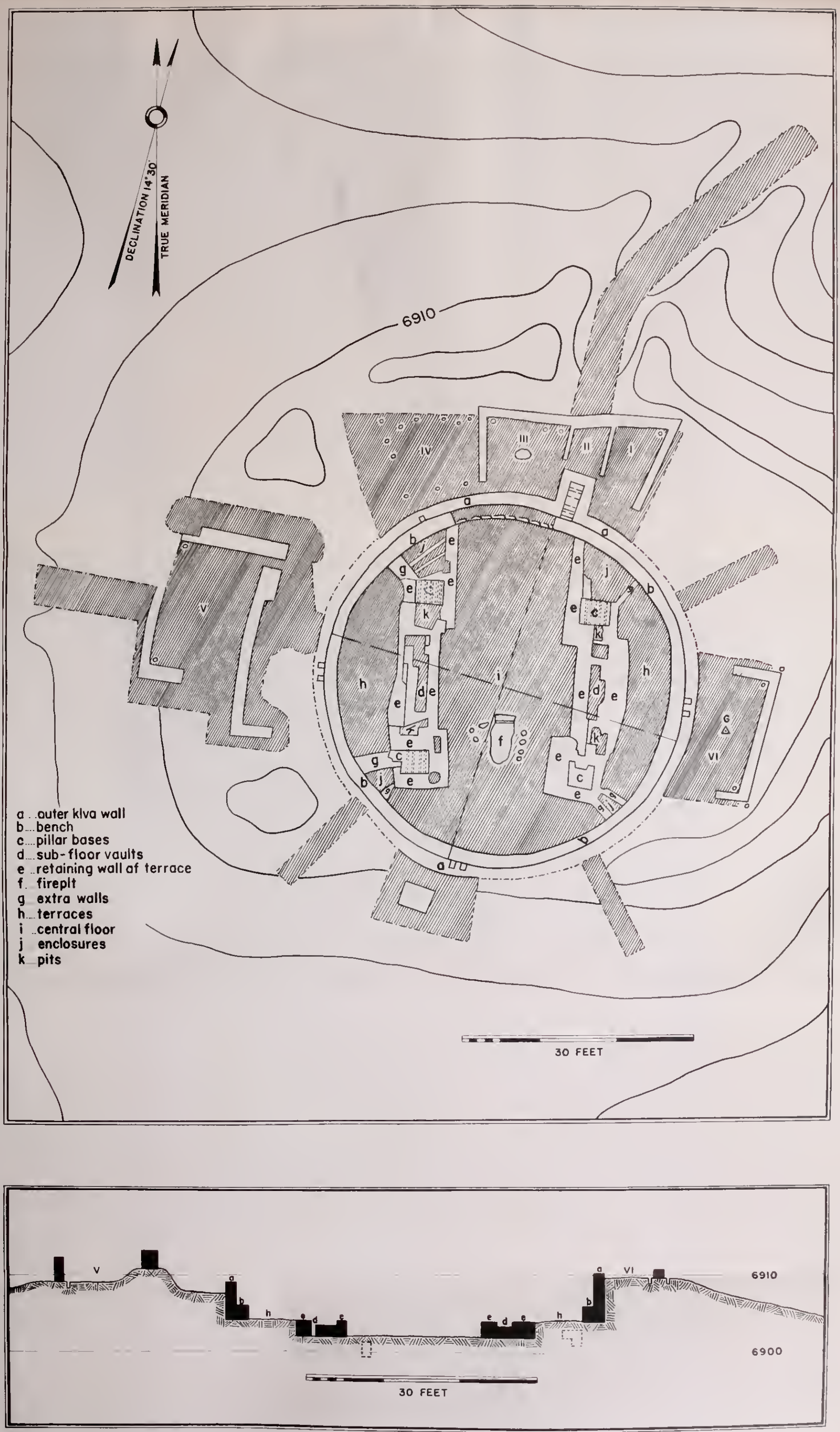
In the wall of the Great Kiva above the bench level are 25 round peg(?) or beam(?) holes or sockets (Plate LXVII). The function of these sockets is unknown. Each one contained the rotten or burned fragments of the butt of a juniper(?) pole. If these sockets occurred at regular intervals in the kiva wall and if they were all located at about the same distance above the bench, I should perhaps conclude that they might have contained secondary roof beams. However, the holes are irregularly spaced horizontally, some being only 1 foot apart and others, 7 feet; they are unevenly spaced vertically, some being 8 inches above the bench, others, 3 feet; and most of them were constructed to hold horizontal poles, although a few might have housed pegs which tilted upwards.

The following data concerning these sockets are available. For the purpose of taking notes, the Great Kiva was divided into quadrants by drawing a diameter through the west edge of the fire-pit and the west side of the recessed stairway and by drawing another diameter at right angles to the first. In the northwest quadrant there are 9 holes; in the northeast, 2; in the southwest quadrant, 7; and in the southeast quadrant, 7. Some of the holes are 1 foot 4 inches deep and others, 3 feet. The diameters vary from 1 to 4 inches.

VAULTS

The vaults (*d*) lie between the pillar bases on the east and west sides of the Great Kiva. The dimensions of the east vault are:

	Feet	Inches
Overall inside length	7	2
Greatest inside width	2	2
Least inside width	1	0
Length of north offset	1	10
Length of south offset	2	0
Depth	1	0



Map 4. GROUND PLAN AND CROSS SECTION OF GREAT KIVA, LOWRY PUEBLO

The west vault is not well preserved and the form is somewhat different (Plate LXVIII), but the length is the same as that of the east vault.

The floor of the east vault is above the level of the central floor; the floor of the west vault is at the same level as that of the central area.

The sides of both vaults are lined with masonry and the floors are of adobe.

No pits or receptacles were observed, nor were any ceremonial deposits recovered from these vaults.

PITS

At each end of both vaults (*d*) and lying between them and the pillar bases is an irregularly shaped pit (*k*) about 5 inches deep. The function of these pits is unknown.

FIREPIT

The firepit (*f*) is nearly centered between the southern pillar bases. It is not a box composed of masonry, but is an oblong pit, with its sides plastered with adobe and its top flush with the floor level. There is a coping of slabs on three sides. When uncovered, this firepit contained a quantity of fine ash.

The dimensions are as follows:

	Feet	Inches
Length (north and south)	5	0
Width	3	4
Depth	0	8
Distance of east edge from southeast pillar	4	6
Distance of west edge from southwest pillar	5	0

DEFLECTOR AND VENTILATOR

No deflector or ventilator was found.

SIPAPU

No sipapu was located.

NICHES

Above the bench in the kiva wall are seven niches (Plate LXIX). They are distributed as follows: one in the northwest quadrant; two in the northeast quadrant, so situated one above the other that the right side of the lower is aligned with the left side of the upper; two in the southeast quadrant, so situated one above the other that the right side of the lower is under the center of the upper; and two in

the southwest quadrant, so situated one above the other that the left side of the lower is aligned with the right side of the upper.

It should also be noted that the single niche in the northwest quarter is in front of the southwest corner of peripheral Room IV; that those niches in the northeast quadrant are in front of peripheral Room VI; and that those niches in the southwest quadrant are in front of peripheral Room V.

When uncovered, the niches were filled with dirt. They are crudely constructed and are capped with stone slabs.

The dimensions of the niches are given in the following table:

DIMENSIONS OF NICHES IN GREAT KIVA

	Height Above Bench		Width	Height	Depth
	Feet	Inches	Inches	Inches	Inches
Northwest quadrant					
One niche	2	0	4	3	10
Northeast quadrant					
Lower niche	0	4	8	5	9
Upper niche	1	4	7	5	10
Southeast quadrant					
Lower niche	0	0	8	5	11
Upper niche	1	8	8	7	10
Southwest quadrant					
Lower niche	0	0	7	6	10
Upper niche	1	6	6	4	9

BENCH

A crudely constructed bench, built against the inner face of the kiva wall, almost completely encircles the Great Kiva. About 13 feet of this bench are missing from the east portion of the northwest quadrant. The missing section had obviously been torn out in ancient times. There are no niches in the face of the bench.

The height of the bench varies considerably. Where it skirts the terrace floor, it ranges in height from 8 inches to 1 foot 6 inches; where it adjoins the central floor, it ranges in height from 2 feet 2 inches to 2 feet 6 inches.

RECESSED STAIRWAY

In the northeast quadrant of the Great Kiva is a recess which once contained a stairway (Plates LXX, LXXI). This stairway evidently consisted of five wooden steps, each of which was composed of three poles. The ends of these poles were embedded in the masonry and the rotted butts were still in place when the kiva was excavated. The steps had a rise of about 11 inches each. The back of

the recess sloped outward from bottom to top. The dimensions of the recess are:

	Feet	Inches
Width	1	10
Depth at bottom	1	9
Depth at top	4	8

The bench constituted the lowest or first step.

OTHER GREAT KIVAS

Roberts (1929, pp. 73–81; 1932, p. 96) lists seven other Great Kivas; namely, Casa Rinconada, the Great Bowl at Chetro Ketl, the Great Kiva at Pueblo Bonito, and the Great Kiva at Shabik'eshchee Village, all in the Chaco Canyon, New Mexico; another at Aztec Ruin, Aztec, New Mexico; and two at the Village of the Great Kivas, Zuñi Reservation, New Mexico. At Wupatki National Monument, Arizona, is another large, circular structure with walls of masonry. This building may also be a Great Kiva (Hargrave, 1933).

Of these eight Great Kivas, seven have been excavated. The Great Kiva at Lowry Pueblo is the ninth to be reported and the eighth to be excavated.

PERIPHERAL ROOMS OF GREAT KIVA

NUMBER AND LOCATION

Six peripheral rooms were uncovered (Map 4; Plate LXXII). Rooms I, II, III, and IV border the kiva to the north; Room V is adjacent to the kiva on the west and Room VI, to the east. Excavations to the south revealed a rectangular block of crude masonry, but no room.

These rooms are all situated on the rim which surrounds the Great Kiva. The floor levels are about 8 feet higher than the central floor of the Great Kiva. The kiva was connected with Room II by means of the recessed stairway.

The dimensions of these rooms are as follows:

DIMENSIONS

Room	Greatest Width of Room		Greatest Length of Room		Thickness of Side Walls		Present Height of Masonry	
	Feet	Inches	Feet	Inches	Feet	Inches	Feet	Inches
I	6	5	15	0	1	6	1	0
II	4	3	6	2	0	8	1	0
III	9	0	10	6	1	6	1	10
IV (Pole-and-brush room)	10	0	12	0	?	?	–	—
V	11	6	15	6	2	5	1	4
VI	9	0	15	0	1	2	1	0

MASONRY

The masonry of peripheral Rooms I, II, III, V, and VI is crude. It consists of four or five courses of masonry or of mixed masonry and unworked stone slabs set on end (Plate LXXIII). In some places the masonry rests on adobe walls, which serve as foundations.

As shown above in the table of dimensions, none of the walls stand very high. It is entirely possible that they never were built up to any great height and that the upper parts of the walls of these rooms were composed of poles and brush.

POLE-AND-BRUSH ROOM

Room IV is unlike the other peripheral rooms, because three of its walls were composed solely of poles and brush or wattle-work. The poles were not carefully aligned. They had been set in the ground at depths varying from 10 to 14 inches and had measured from 6 to 8 inches in diameter. There had been five of these poles in the north wall, four in the west wall, and two in the south wall. The west wall of Room III formed the fourth wall (Plate LXXIV).

The evidence for all this was found fortuitously.

I had expected to uncover a series of arc-shaped, peripheral rooms such as Morris had found at Aztec (Morris, 1928, pp. 115–138). Quite by chance, Rooms I, II, and III were the first peripheral rooms to be excavated. In digging further, however, to the west of Room III, it became apparent that there were no more walls of masonry. But, in searching for such walls, quantities of charred poles and burned clay, bearing the imprint of branches and poles, had turned up. Since this digging was being done on the crest of the kiva rim, from 6 to 8 feet above the surrounding terrain, these burned logs and pieces of baked clay could not have drifted up there. I reasoned, therefore, that a pole-and-brush structure had once stood in that area. Forthwith, that whole space now marked as IV on the ground plan was carefully worked over, with the result that eleven post-holes were discovered. From each of them were recovered fragments of an upright post, a fill composed of fine dirt and small rocks, and a small, discoid stone bead.

Further, in every trench that was cut through the kiva rim, pieces of charred poles and bits of burned clay were observed. It is entirely possible, therefore, that peripheral Rooms I to VI were joined by a series of pole-and-brush enclosures (like Room IV), thus making a complete series of rooms around the Great Kiva.

FLOORS

The floors are of hardened adobe which had been neatly rubbed and smoothed.

FIREPIT

Room III contains a firepit which is lined with adobe plaster and has no coping. The diameter of this pit is 3 feet and the depth 1 foot. Ashes were found in it when it was uncovered.

ROOFS

Post-holes, one to each rear corner, were found in the floors of Rooms I, III, V, and VI. These holes were about 1 foot deep and contained the decayed butts of upright poles, the diameters of which had ranged from 6 to 8 inches. From the bottom of each hole a small, discoid stone bead was recovered.

It seems fair to assume that these posts supported the pole-and-brush portion of the walls and the roof. If so, it is possible that the upper ends of these roof posts were forked and that the crotch thus made provided a rest for the roof beams.

REMARKS ON GREAT KIVA AND PERIPHERAL ROOMS

At the present time, none of the walls of the peripheral rooms abut on the outer kiva wall. It is, therefore, impossible to state whether they were enclosures set apart from the kiva or whether they were an integral part of the kiva structure and included under the kiva roof. It is equally impossible to assert that there were doorways opening from these peripheral rooms into the Great Kiva as there are in the Great Kiva at Aztec, New Mexico (Morris, 1928, p. 130).

In the eastern part of Room V is a secondary wall, the base of which is higher than that of the west wall of this room. I do not understand what purpose this secondary wall served.

A pit sunk into the floor of the northwest quadrant of the Great Kiva disclosed the remains of another circular building which may also have been a Great Kiva.

IV. ARTIFACTS OF LOWRY PUEBLO

Objects of Stone

Surprisingly few stone objects were recovered from either the pueblo or the rubbish heaps.

The classifications given herewith are after Kidder (1932). Mr. Sharat K. Roy, Assistant Curator of Geology of Field Museum, made the macro-examination of these stone objects.

STONE IMPLEMENTS WITH SECONDARY CHIPPING ON ALL MAJOR FACES

A. Projectile Points and Knives with Stems

(1) Expanding stem narrower than shoulder. Three specimens of chert, one with serrated edges. Range in length from ¾ inch to 1½ inches; range in weight from 0.8 grams to 2.3 grams. Found in Mancos black-on-white rubbish heap (Fig. 8, *a–c*).

(2) Expanding stem as wide as, or wider than, shoulder.

Subtype *a;* slender with narrow notches. Six specimens of chert. Range in length from ⅝ inch to 1¼ inches; weights range from 0.4 grams to 1.5 grams. Found in Mancos black-on-white rubbish (Fig. 8, *d–i*).

Subtype *b;* broad with larger notches. One specimen of chert. Length 2¼ inches; weight 9.5 grams. Found in Mancos black-on-white rubbish (Fig. 9, *a*).

B. Aberrant Form

Crescent-shaped object of white chalcedony. Length 2 1/16 inches; weight 4.5 grams. Found on surface of Room 11 (Fig. 10, *e*).

GROUND OR PECKED STONE OBJECTS

Ax of quartzite with plain, narrow, shallow groove, set at right angles to long axis; groove deeper on edges than on faces; poll battered; edge dull; faces polished. Length 3½ inches, width 2¼ inches, thickness 1¾ inches; weight 12 ounces. Found in Mancos black-on-white rubbish, near floor of Room 6 (Fig. 11, *b*).

Ax of fine-grained, pink granite with plain, broad, shallow groove; poll battered; edge sharp; faces polished. Length 5 inches, width 2½ inches, thickness 2 inches; weight 1 pound 4 ounces. Found in Mancos black-on-white rubbish near floor of Room 6 (Fig. 11, *a*).

Maul(?) of spherulitic basic igneous rock with all-around plain groove; faces and groove smooth but not polished; specimen bat-

FIG. 8. Projectile points. *a–c*, Expanding stem narrower than shoulder; *d–i*, Expanding stem as wide as, or wider than, shoulder, slender form, narrow notches. Length of *a*, 1½ inches.

tered and damaged. Length 3¾ inches, width 2¼ inches, thickness 1¾ inches; weight 12 ounces. Found in Mancos black-on-white rubbish near floor of Room 8 (Fig. 11, *c*).

Notched implement of highly calcareous sandstone, notched on either side near middle; ends rounded, blunt, and scarred; made from worn-out, wedge-shaped mano. Length 5¼ inches, width 3½ inches, thickness 1¼ inches; weight 1 pound 4 ounces. Found on floor of Kiva A, near firepit (Fig. 12, *a*).

Problematical grooved implement of quartzite with completely encircling, plain, broad, shallow groove set at right angles to long axis; poll square and polished; other end pointed and polished; faces and edges (except in groove) polished. On one face, near conical end, two tiny, drilled pits, set ½ inch apart, 3/16 inch in diameter and 1/16 inch deep; protuberance or shoulder on one edge just above groove. Length 4¾ inches, width at notch 2½ inches, thickness 1¼ inches; weight 15 ounces. Found on floor of Kiva A near firepit. Use unknown; form suggests a fetish(?) (Fig. 11, *d*).

Shouldered implement of silicified tuff; turquois blue-green color produced by ferrous silicate; haft end incomplete and narrowed by shoulders or offsets; blade beveled and slightly polished; faces and edges smooth but unpolished. Length 8⅞ inches, greatest width 4⅝ inches, thickness ⅛ inch; weight 12 ounces. Found with several bone implements wrapped in remains of twilled cedar mat, three feet under south wall of Room 16. Use unknown; very fragile and unsuited for utilitarian purposes, but may be similar to a *tcamahia* (Fig. 13).

Pot polishers of quartzite; four found, two brown, one gray, and one black; probably picked up in some stream bed; all highly polished. Lengths vary from 1¼ inches to 2 inches. Probably used for finishing vessel surfaces. Two brown ones found in Mancos black-on-white rubbish; the other two on banquette of Kiva A (Fig. 9, *d*, *e*).

Stone ball of quartzite; an egg-shaped, smooth river pebble. Length 3¼ inches; width 2¼ inches. Found on floor of Kiva A. Use unknown (Fig. 12, *c*).

Stone ball of ferruginous sandstone; ovaloid in shape; surface is very rough and shows pecking marks; hole drilled through from end to end. Length 2½ inches, width 2¼ inches. Found on floor of Kiva A. Use unknown (Fig. 12, *b*).

Metate (the nether element of the Pueblo corn mill) of conglomerate; upper side troughed, the trough open at both ends; rectangular

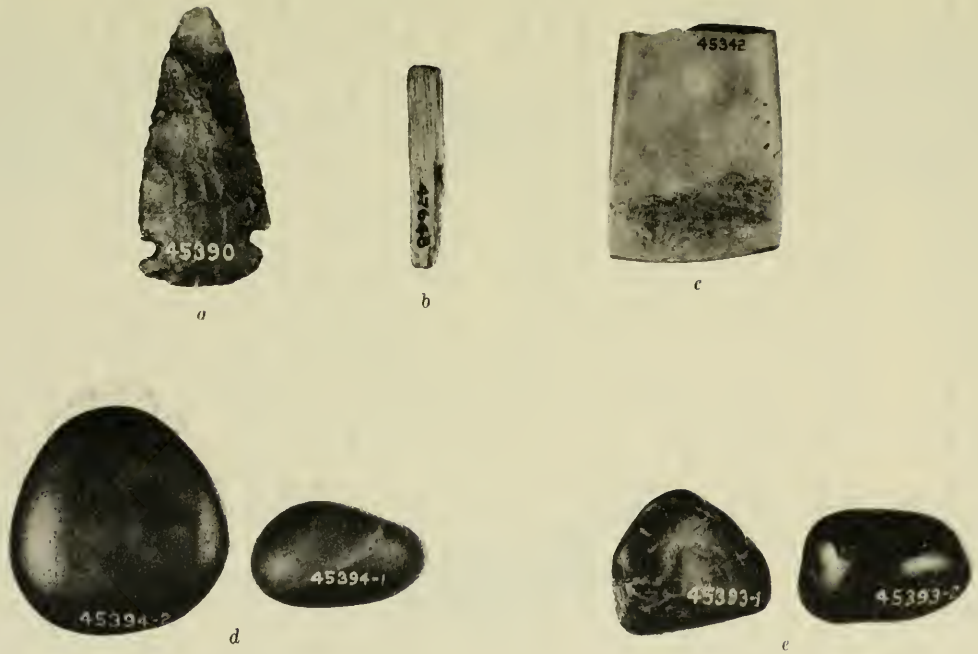


FIG. 9. Miscellaneous objects of stone. *a*, Projectile point with broad stem and large notches; *b*, Problematical object of steatite; *c*, Tablet of felsite; *d*, *e*, Pot polishers of quartzite. Length of *a*, 2¼ inches.

with rounded ends; under side flat and unworked. Length 1 foot 4 inches, width 1 foot 2 inches, thickness 4 inches. Mano (the upper element of the Pueblo corn mill) of sandstone; wedge-shaped; single grinding surface; upper surface rough; grinding surface convex; rounded end. Length 8 inches, width 4 inches, thickness 1½ inches. Both metate and mano found on floor of Kiva F near firepit (Plate LXXV).

Metate of conglomerate; upper side troughed, the trough open at one end only; rounded ends; under side rough and unworked. Length 1 foot 8 inches, width 1 foot 3 inches, thickness 6 inches. Mano of sandstone; wedge-shaped; single grinding surface; upper surface rough; grinding surface convex; roundish end. Length 9 inches, width 4 inches, thickness 1½ inches. Both metate and mano found three feet under floor of Room 11 in the remains of a Basket Maker III(?) house (Plate LXXVI).

Metate of conglomerate; one side troughed, the trough open at both ends; the other side flat and untroughed; ends roundish. Length 1 foot 5 inches, width 1 foot, thickness 5 inches. Metate, without any mano, found on floor of Room 13.

Metate of conglomerate; upper side troughed, the trough open at both ends; under side unworked; ends rounded. Length 1 foot 6 inches, width 1 foot 1 inch, thickness 3 inches. Two manos of sandstone; wedge-shaped; single grinding surface; upper surface rough; grinding surface convex; rounded end. Dimensions of first mano: length 8 inches, width 4 inches, thickness 2 inches. Dimensions of second mano: length 9 inches, width 4 inches, thickness 1½ inches. Metate and both manos found on floor of Room 15.

Three metates of conglomerate; upper sides troughed, the troughs open at both ends; under sides flat and unworked; rounded ends. Lengths vary from 16 inches to 20 inches, widths from 13 inches to 16 inches, thicknesses from 3 inches to 5 inches. These metates without manos found on floor of Room 16.

Three metates, two of conglomerate and one of sandstone; upper sides troughed, the troughs open at both ends; under sides flat and rough; rounded ends. Lengths vary from 14 inches to 21 inches; widths from 12 inches to 15 inches, thicknesses from 3 inches to 6 inches. Also, three manos of sandstone; wedge-shaped; single grinding surface; upper surface rough; grinding surface convex; rounded end. Lengths vary from 8 inches to 11 inches, widths from 3½ inches to 5 inches, thicknesses from 1½ inches to 2½ inches. These

FIG. 10. Miscellaneous objects of stone. *a–c*, Stone pendants; *d*, Zoomorphic image of stone; *e*, Crescent-shaped object of chalcedony; *f*, Ring(?) of trachyte. Diameter of *a*, 15/16 inch.

metates and manos found on slab floor of Room 18 (room over Kiva D).

Two metates of conglomerate; upper sides troughed, the troughs open at both ends; under sides flat and unworked; ends rounded. Lengths 16 and 18 inches, widths 13 and 15 inches, thicknesses 5 inches. These two metates, without manos, found on floor of Great Kiva.

Total number recovered: 12 metates and 7 manos.

Tablet of felsite; green in color; incomplete but rectangular in shape; sides and faces well polished. Length 1¾ inches, width 1¼ inches, thickness 3/16 inch; weight 21.9 grams. Found in Mancos black-on-white rubbish heap. Use unknown (Fig. 9, *c*).

Zoomorphic image of felsite; probably represents a bird; bulging eyes; hole drilled through from side to side; well polished. Length ¾ inch. Found in Mancos black-on-white rubbish heap. Use unknown, but probably served as a pendant (Fig. 10, *d*).

Problematical object of steatite; edges and faces well polished; one end tapered, other end squared. Length 1 9/16 inches, width ¼ inch, thickness 1/16 inch. Found in Mancos black-on-white rubbish heap. Use unknown (Fig. 9, *b*).

Stone pendants; two of limestone, one of trachyte; round; smooth but not polished; drilled for suspension. Diameters are 15/16 inch, ½ inch, and ⅞ inch; thickness of all three, 1/32 inch (Fig. 10, *a–c*).

Stone ring(?) of trachyte; smooth but not polished. Diameter ⅝ inch, thickness ⅛ inch. Found in Mancos black-on-white rubbish heap. Use unknown (Fig. 10, *f*).

Hemispherical object of limestone; highly polished; no perforations; looks somewhat like a cat's-eye; gray in color. Diameter 11/16 inch. Found in Mancos black-on-white fill in Room 3 (Fig. 14, *e*).

Two buttons(?) of sandstone; form of an oblate spheroid with equatorial bulge or, more accurately, form of a circular spindle; smooth but not polished. Perforated just below "equator." Diameters at bulge ⅝ inch and ⅞ inch. One of these found on floor of Room 10; the other, on floor of Room 3. Use unknown (Fig. 14, *d*).

Two "medicine cylinders," one of limestone and one of sandstone; polished; brown in color. Lengths 11/16 and ⅞ inch; diameters of both 7/16 inch. Found in Kiva A on banquette of west quadrant (Fig. 14, *f*).

FIG. 11. Grooved objects of stone. *a*, *b*, Axes; *c*, Maul(?); *d*, Problematical object. Length of *a*, 5 inches.

Anthracite coal, unworked. Length 1 inch, width ⅝ inch, thickness 7/16 inch. Found near floor of Room 10. Use unknown.

OBJECTS OF CLAY

Effigy of human head; round face, eyes, and mouth represented by horizontal slits; nose modeled with pair of punctations at lower end to represent openings of nostrils; ears lacking. Across forehead is a painted line; over and at side of mouth is a bit of design in mineral paint; almost entire back of head is covered with black mineral paint. In vertical axis is a perforation which runs completely through. Object appears not to have been attached to any vessel. Height 1¼ inches, width 1¼ inches, thickness 1 inch. Found on floor of Kiva A. Use unknown (Fig. 14, *b*).

Worked potsherd; roundish; perforated near edge; smooth edge; made from bowl sherd of black-on-red(?) ware, but red paint mostly scraped off. Diameter 1½ inches. Found in Mancos black-on-white rubbish (Fig. 14, *c*).

Worked potsherd; roundish, perforated near edge; smooth edge; made from bowl sherd of Tusayan black-on-red ware. Diameter 1¾ inches. Found in McElmo black-on-white rubbish in Room 8 (Fig. 14, *a*).

Tobacco pipe; elbow type with stem; bowl with obtuse angle to stem; unslipped but decorated with two black bands (mineral paint) one around rim of bowl and one at junction of bowl and stem; smoke passage off-center; part of mouthpiece missing. Length 2½ inches, bowl height 1 inch, bowl diameter 1 inch, bore ⅛ inch. Found in McElmo black-on-white rubbish level in Room 8 (Fig. 15, *b*).

Tobacco pipe; elbow type with stem; bowl at obtuse angle to stem; slipped white and decorated with seven black bands (mineral paint). Length 3½ inches, bowl height 1¼ inches, bowl diameter 1 inch, bore ⅛ inch. Found at bottom of ventilator shaft of Kiva A (Fig. 15, *c*).

Tobacco pipe; fragmentary; elbow type with stem; bowl at right angle to stem; slipped(?) white and decorated with squiggly hatch and an "*x*" and vertical lines, all done with mineral paint; smoke passage off-center; portions of bowl and mouthpiece missing. Length 2½ inches (plus), height undeterminable, bowl diameter about 1 inch, bore ⅛ inch. Found on floor of Room 15 (Fig. 15, *a*).

No dottel was recovered with these pipes nor are the interiors blackened by smoke.

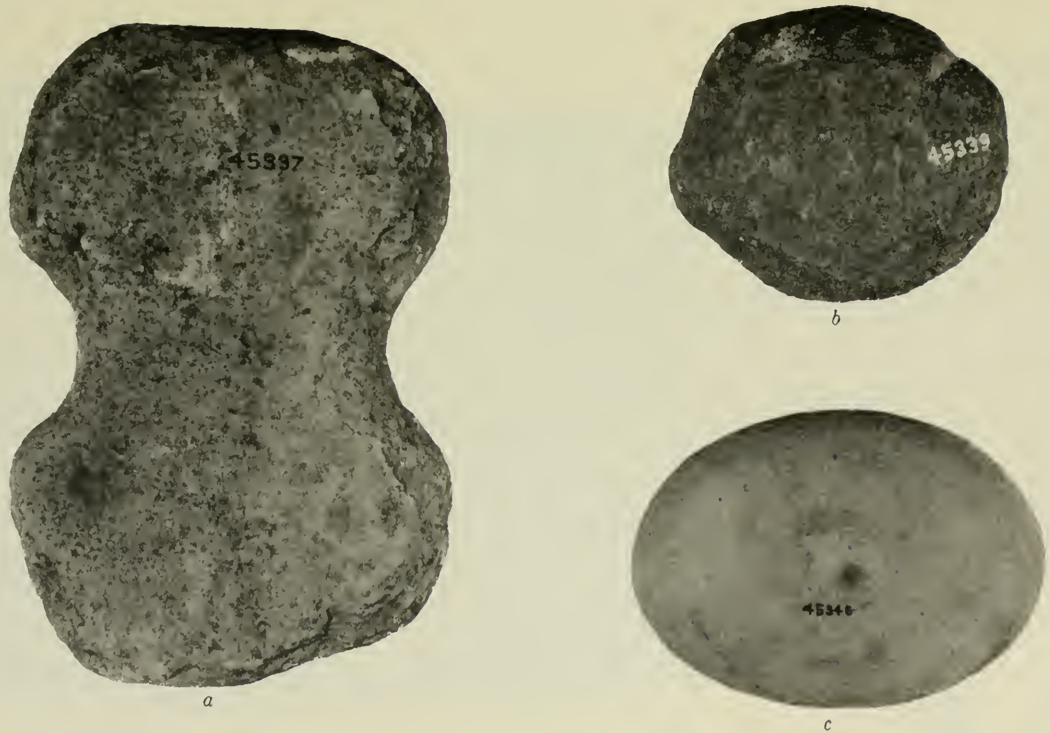


FIG. 12. Miscellaneous objects of stone. *a*, Notched implement; *b*, *c*, Stone balls. Length of *a*, 5¼ inches.

Fig. 13. Shouldered implement of silicified tuff. Length, $8\frac{7}{8}$ inches.

FIG. 14. Miscellaneous objects of pottery and stone. *a, c*, Worked potsherds; *b*, Pottery-effigy of human head; *d*, "Buttons"(?); *e*, Hemispherical object; *f*, "Medicine cylinders." Diameter of *a*, 1¾ inches.

FIG. 15. Tobacco pipes of pottery. Length of *a*, 2½ inches.

a b c d e

FIG. 16. Awls of mammal leg bones; head of bone intact. Length of *a*, 8⅝ inches.

FIG. 17. Awls of mammal leg bones; head of bone intact. Length of a, 4¾ inches.

OBJECTS OF BONE

(Unless otherwise specified, all these objects came from Mancos black-on-white rubbish.)

I. *Implements.*

A. Awls.

(1) Mammal leg bone.

(*a*) Head of bone intact; made from ulnae, metapodials, and femora of elk, deer, moose, and carnivores; range in length from 2½ inches to 8⅝ inches; average about 5 inches (Figs. 16, 17) 14

(*b*) Head of bone partly worked down; made from metapodials of deer and elk(?); range in length from 2 13/16 to 9 inches; average about 4 inches (Figs. 18, 19) ... 13

(*c*) Head of bone wholly removed; probably made from metapodials of deer and elk; range in length from 2¼ inches to 8½ inches; average about 4½ inches (Fig. 20) 11

(2) Whole bird bone; tibia and metatarsals of turkey used; range in length from 2⅜ inches to 5⅛ inches; average about 4 inches (Fig. 21) 7

B. Needles; shorter one made from bird bone; length 3¾ inches; eye 13/16 inch long and 3/16 inch wide. Longer one made from mammal leg bone; length 5⅜ inches; eye 9/16 inch long and 3/16 inch wide. Eyes probably made by both drilling and cutting (Fig. 22, *a*) 2

C. Polishers(?) probably made from splinters of mammal leg-bones. Length of shorter one 3¼ inches and width 11/16 inch. Length of longer one 4 inches, and width ⅞ inch (Fig. 22, *b*) 2

D. End scrapers or fleshers.

(1) Made from metatarsals of bison or elk; both lengths 5⅞ inches; articular surface of one split in half. Found in cache under south wall of Room 16 (Fig. 23, *b*, *c*) 2

(2) Made from humeri of mountain sheep; lengths 5 inches and 5¾ inches (Fig. 23, *a*, *d*) 2

(3) Made from humerus of ungulate; length 4¼ inches (Fig. 23, *e*) 1

(4) Made from phalange of deer; length 1⅞ inches (Fig. 23, *f*) 1

E. Problematical bone object; made from mammal bone; delicate and well-polished; length 3½ inches (Fig. 22, *d*)......1

II. *Whistle*(?); made of bird bone; pierced by single hole produced by cutting through a notch; length 1 inch, outside diameter ½ inch (Fig. 22, *e*)......................................1

FIG. 18. Awls of mammal leg bones; head of bone partly worked. Length of *a*, 5¾ inches.

III. *Bone tubes;* made from bird wings; range in length from ⅞ inch long to 3⅞ inches; diameters all about ¼ inch. These may have been employed as beads because of the worn and polished appearance of their ends and sides (Fig. 24)........11

IV. *Miscellaneous.*

A. Perforated disk; made from mammal bone; diameter 11/16 inch, thickness ⅛ inch. Diameter of perforation, which was drilled from one side only, is 3/16 inch (Fig. 22, *c*)..........1

B. Portion of curved ornament(?); probably made from mammal bone, steamed and bent; small perforation at one end. Chordal length 2⅜ inches; width 7/16 inch (Fig. 22, *f*)........1

Total number of bone objects......................70

OBJECTS OF ANTLER

Digging stick blade(?) of mountain sheep horn; blade somewhat beveled and slightly worn; length 7 inches, width 2¾ inches. Found with shouldered implement of tuff under south wall of Room 16 (page 56 and Fig. 25, *a*).

Implements(?) of elk horn: 2 pieces (portions of main beams?) with wedge-shaped tips; the burr and a small part of the main beam, the tip of which is beveled on one side; and a tine with unmodified tip. Found, along with whole pottery, on floor of Kiva F. May have been portions of a head-dress, but more probably served as general utility tools (Fig. 25, *b*).

OBJECTS OF WOOD

Cylindrical stick of pinyon(?); surface smooth and devoid of bark or knots; ends convex and well worked. Length 12 inches, diameter 1 inch. Found on bench of Kiva B. Use unknown, but may have served as a gaming(?) stick.

Prayer-sticks(?) of willow. These fragments of prayer-sticks were not found at Lowry ruin. They were dredged, along with several pieces of pottery, from an ancient spring, which is about five miles east of Lowry ruin on the property of Mr. Courtney Dow. I assume that these prayer-sticks were placed in the spring as offerings.

FIG. 19. Awls of mammal leg bones; head of bone partly worked. Length of *a*, 9 inches.

FIG. 20. Awls of mammal leg bones; head of bone wholly removed. Length of k, $8\frac{1}{2}$ inches.

FIG. 21. Awls of bird bone. Length of *a*, $5\frac{1}{8}$ inches.

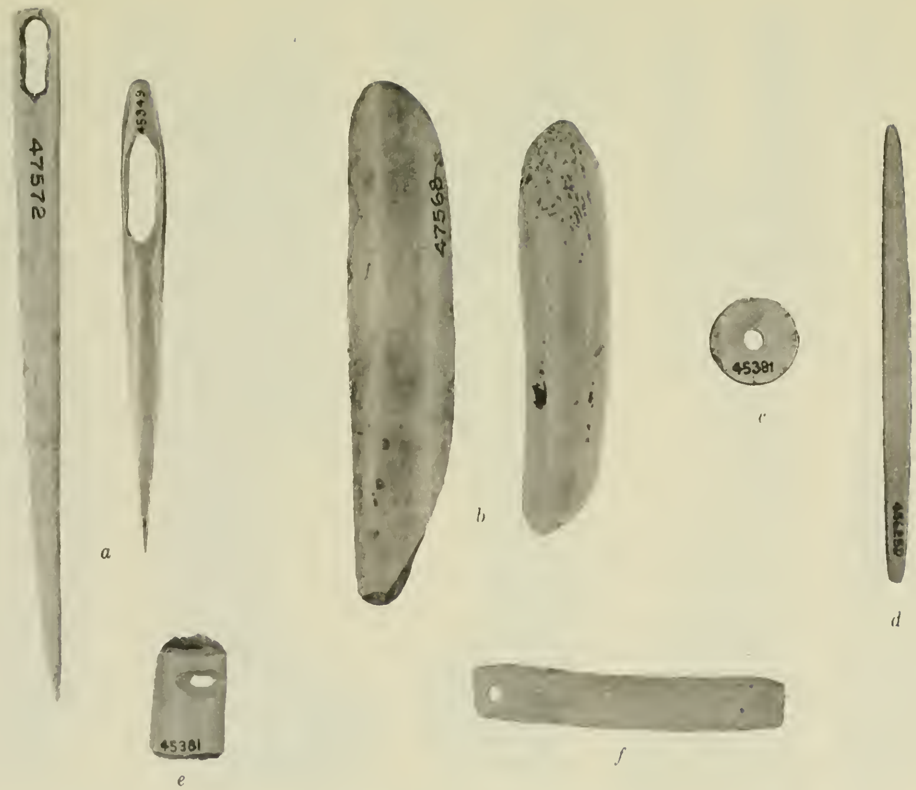


Fig. 22. Miscellaneous objects of bone. *a*, Needles; *b*, Polishers(?); *c*, Perforated disk; *d*, Problematical object; *e*, Whistle(?); *f*, Portion of curved ornament. Length of *a*, 5⅜ inches.

FIG. 23. End scrapers. Length of *a*, 5¾ inches.

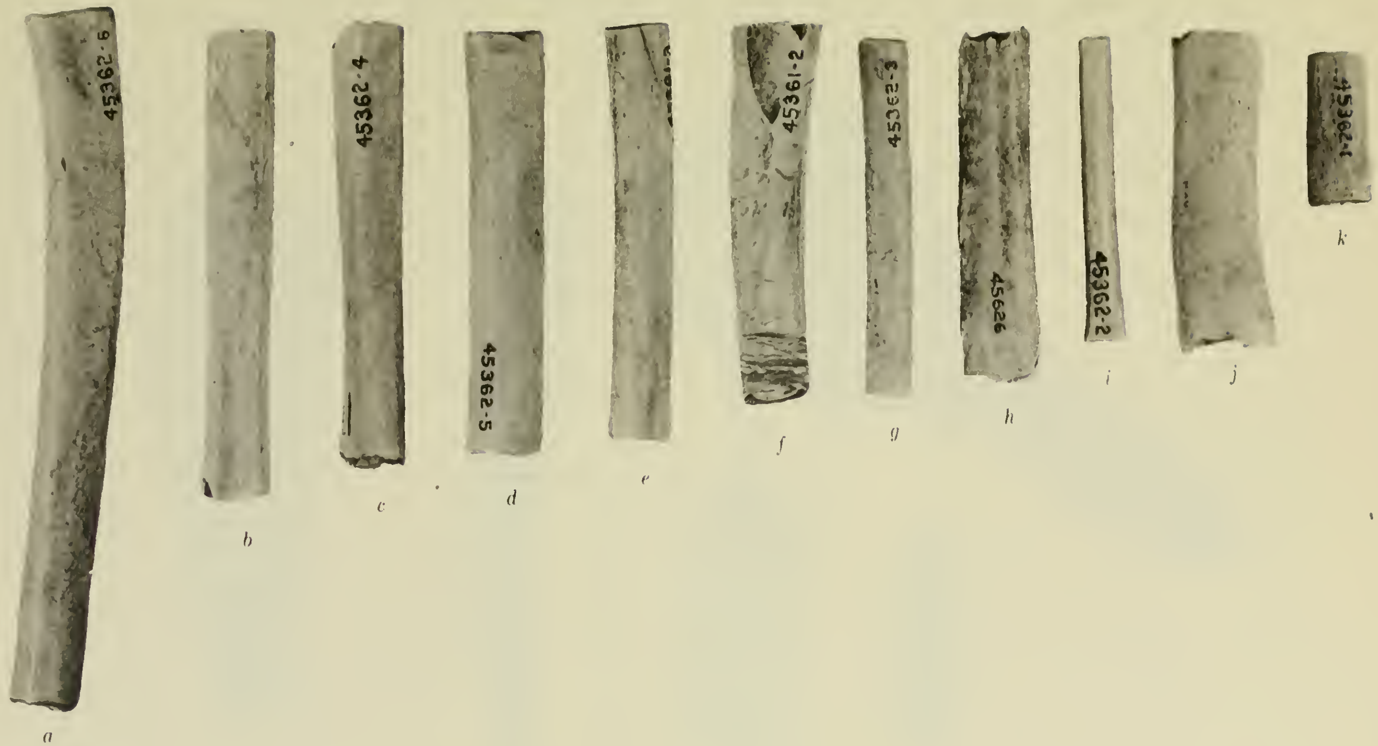


FIG. 24. Bone tubes. Length of *a*, 3⅞ inches.

FIG. 25. Objects of antler. *a*, Digging stick blade(?); *b*, Implements(?) of elk horn. Length of *a*, 7 inches.

V. POTTERY OF LOWRY PUEBLO

Classification Used

The ceramic classification used herein is that worked out and published by Gila Pueblo (Gladwin, 1934, Medallion Papers, No. XV). I am aware that a purely mechanistic classification of pottery (or of any archaeological object), the meaning of which is not known and never will be known, is dangerous. Certain differences of techniques and designs may appeal to one as being significant and indicative of culture changes. But, obviously, a classification based on these differences is objective, since one can not know the *meaning* of these differences in techniques and designs. They may be real; they may be only apparent.

However, in working with archaeological data, it is necessary to arrange the available material in some orderly fashion. From such an arrangement, apparently significant variations may appear and may be used, along with other algebraic factors, to delineate certain problems. If the arrangement is sterile, it may be discarded and another one set up.

The classification as worked out by the Gladwins is convenient and fits all the known facts. It is frankly tentative and will be modified from time to time. It does not pretend to be more than a working hypothesis.

Pottery Types Found at Lowry Ruin

I have grouped the Lowry pottery into two divisions: one containing the wares which I believe were produced on the site; the other, the wares which were probably obtained through trade.

LOWRY POTTERY TYPES

(1) Lino gray ware—Basket Maker III to Pueblo I (Hargrave, 1932, p. 11).

(2) Lino black-on-gray ware—Basket Maker III to Pueblo I (Hargrave, 1932, p. 12).

(3) Undecorated, slipped(?) ware—Basket Maker III to Pueblo I (Roberts, 1929, plate 17*a*).

(4) Mancos black-on-white (mentioned by Gladwin, 1934, p. 28) (described in this Report for the first time).

(5) Red Mesa black-on-white (corresponds to Roberts' "Chaco transitional") (Gladwin, 1934, p. 20).

(6) Wingate black-on-white (corresponds to Roberts' "Chaco degenerate transitional") (Gladwin, in preparation).
(7) McElmo black-on-white (formerly called "Proto-Mesa Verde") (Kidder, 1924, p. 67).
(8) Mesa Verde black-on-white (Kidder, 1924, pp. 61–64).
(9) Plain corrugated-neck ware.
(10) Indented corrugated-neck ware.
(11) Indented-corrugated ware (indented and corrugated all over).

TRADE WARES

(1) Sunset redware (Hargrave, 1932, p. 18).
(2) Wingate black-on-red (Gladwin, 1931, p. 29).
(3) Abajo red-on-orange (J. O. Brew, in preparation).
(4) Black Mesa black-on-white (Morss, 1931, pp. 3–4).
(5) Tusayan black-on-white (formerly called "Proto-Kayenta black-on-white") (Kidder, 1924, p. 72; Morss, 1931, pp. 5–10).
(6) Tusayan black-on-red (formerly called "Proto-Kayenta black-on-red") (Kidder, 1924, p. 72).
(7) Tusayan polychrome (Kidder, 1924, p. 72).
(8) Puerco black-on-red; only 4 sherds found (Gladwin, 1934, p. 20).

With the exception of Mancos black-on-white pottery, all these wares have already been or are about to be described. Therefore, Mancos black-on-white and the accompanying corrugated pottery only will be treated here.

Definition of Mancos Black-on-White Pottery

The name Mancos black-on-white was suggested by Mr. Earl Morris. This term was then incorporated in Gladwin's pottery classification (Gladwin, 1934, p. 28) although the pottery itself has never been described.

A. PAINTED POTTERY

Vessel Shapes and Sizes (percentage of total amount of each type of pottery collected given in parentheses).—Bowls (67 per cent): Diameters range from 4 to 10 inches and heights from 2 to 5 inches; contours are wavering and sometimes asymmetrical; bottoms are often flat but sometimes rounded and are always smaller in

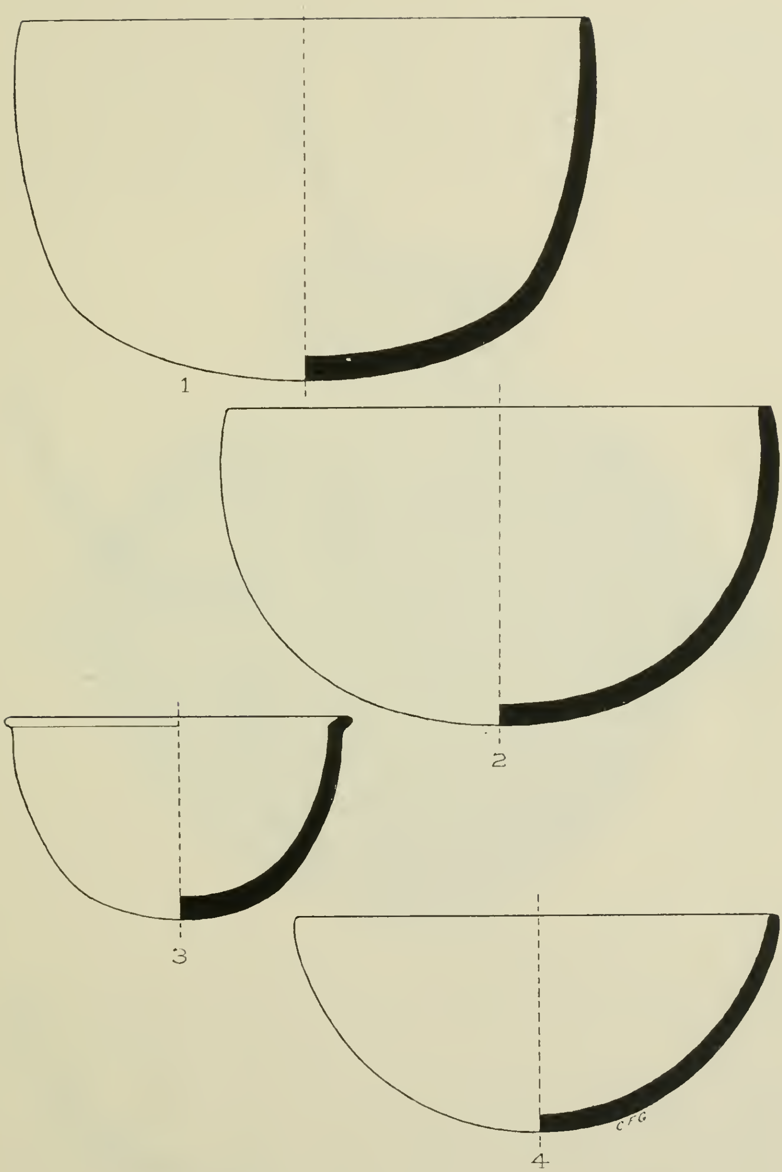


FIG. 26. Bowl forms of Mancos black-on-white pottery.

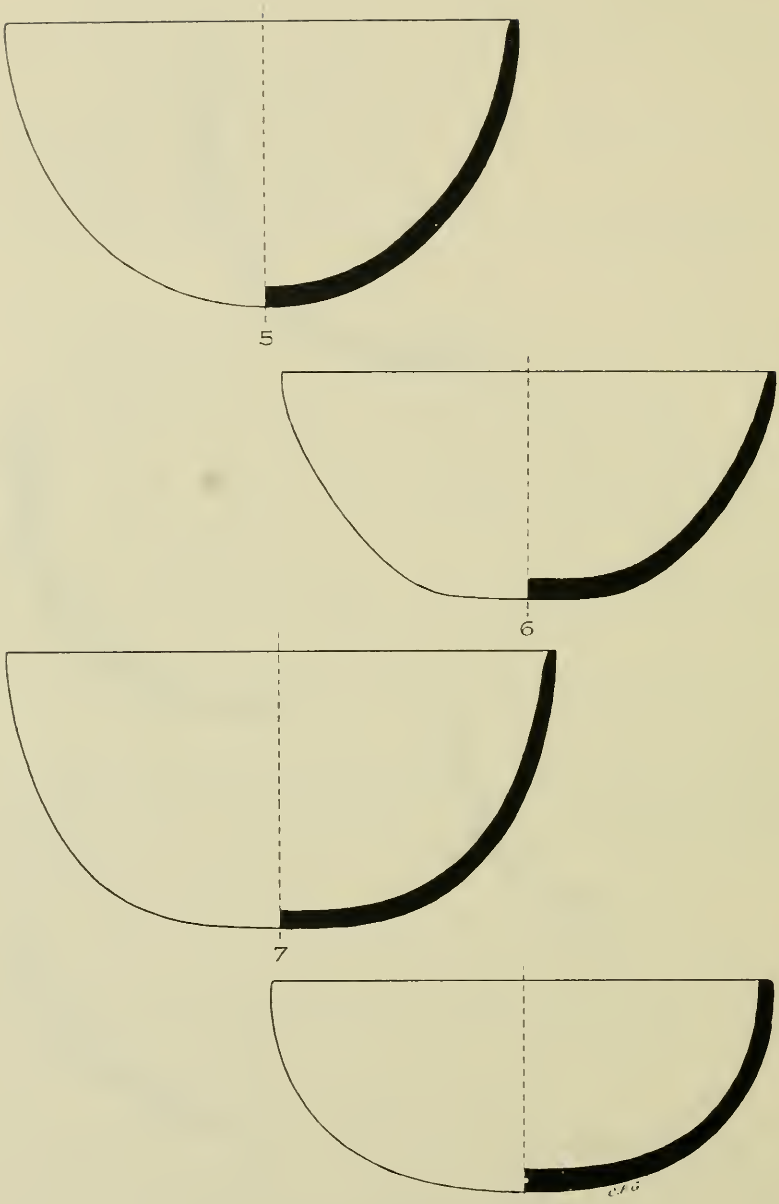


FIG. 27. Bowl forms of Mancos black-on-white pottery.

circumference than rim; sides are rather straight and tend to slope out from bottom to top (Figs. 26, 27).

Jars (26 per cent): Heights range from 7 to 16 inches and diameters from 6½ to 15 inches. Necks are vertical, cylindrical, short, and restricted; bodies are globular and shoulders rather angular. Handles are of two types: single loops or flat bands set horizontally just below the shoulder; and loops (the central portions of which are pushed in and welded to the side of the jar) placed just below

FIG. 28. Mancos black-on-white jar. Height, 7 inches.

the shoulder and raked downward somewhat (Figs. 28, 29). No indented handholds were noted.

Ladles (7 per cent): Bowl-and-handle type; overall lengths range from 5 to 11 inches; bowl diameters from 2½ to 5 inches. Handles consist of tubes (sometimes containing pellets and often bearing small perforations on the upper surface), flat bars, or loops of clay. The ends of the handles are bifurcated, pointed, or rounded (Fig. 30).

Pitchers and mugs probably exist; but no complete pieces were recovered.

Slip.—The interiors of most bowls and ladles are, generally, though not always, slipped with a rather thin, chalky white to slaty gray, unpolished slip. The slip is so thin that the gray base-color of the vessel often shows through. Brush marks may occasionally be seen. Jars are generally slipped, although not always. It is possible that Mancos pottery was unslipped before the advent of Red Mesa black-on-white, and thereafter slipped. Bowl exteriors are generally

FIG. 29. Mancos black-on-white jar. Height, 16 inches.

unslipped. The presence or absence of slip should be determined microscopically, since it is otherwise impossible to be certain. I was unable to have these necessary microscopic examinations made; my remarks, therefore, concerning slip should not be taken as final.

Paint.—The vessels are decorated with mineral pigments. The color of the paint may be a transparent brown, a greenish brown, a reddish brown, or a dense, flat black. The paint is matt in most cases. Miss Anna O. Shepard, of the Laboratory of Anthropology, Santa Fe, New Mexico, examined seventeen sherds of Mancos black-on-

white pottery and made chemical tests of the paint on these sherds. All the samples yielded a strong test for iron and none for manganese. The paint on a few specimens was strongly magnetic, on others, weakly magnetic, and on still others, non-magnetic. When microscopically examined, the paint has a granular texture, stands out in relief, and sometimes appears in caked patches. This is so because mineral pigments are insoluble and are applied as suspensions. The hardness of a mineral pigment bears no relation to that of the clay upon which it is applied. If the paint is unsintered (unglazed) it may be softer than the clay surface; if vitrified, it will be harder. Mineral paint is more often affected by wear than organic paints. It is not at all certain that mineral pigments were mixed with organic pigments and the presence of carbon must yet be proven—a very tedious task. It is entirely possible that an organic vehicle was originally used, but being in a comparatively open, non-adsorptive material the carbon was entirely oxidized in the firing. Following Miss Shepard's technique, I applied an oxidation test to about one hundred Mancos black-on-white sherds. I therefore feel that the analysis of the paint given herewith is reasonably correct and is not mere guesswork.

Decoration.—Brush work crude and uneven.

I. Zone of decoration on bowls and ladles.
   A. Exterior walls of bowls and ladles undecorated, with two exceptions: on the bottom of one bowl, a small "x"; and on the side of the other, two sets of "turkey tracks."
   B. Interior walls. No "life line" noted on either bowl lips or bowl interiors.
      (1) Continuous band patterns: crudely drawn bands (Fig. 31, *b*); checkerboard patterns in either rectangular or triangular units (Fig. 32, *a*); checkerboard patterns with one set of squares containing each a dot and the opposing set, hatching (Fig. 32, *b*); opposed triangles; pendent triangles either solid black or hatched (Fig. 33, *b*); terraces pendent from the rim (Fig. 34, *b*); and frets (Fig. 33, *a*).
      (2) Divided band patterns: panels produced by oblique, parallel lines, bordered by dots and opposed triangles set within the panels (Fig. 35, *c*); panels of vertical lines and large triangles within panels (Fig. 34, *a*); and vertical sets of parallel lines set off from one another by solid and void rectangles (Fig. 36, *a*).

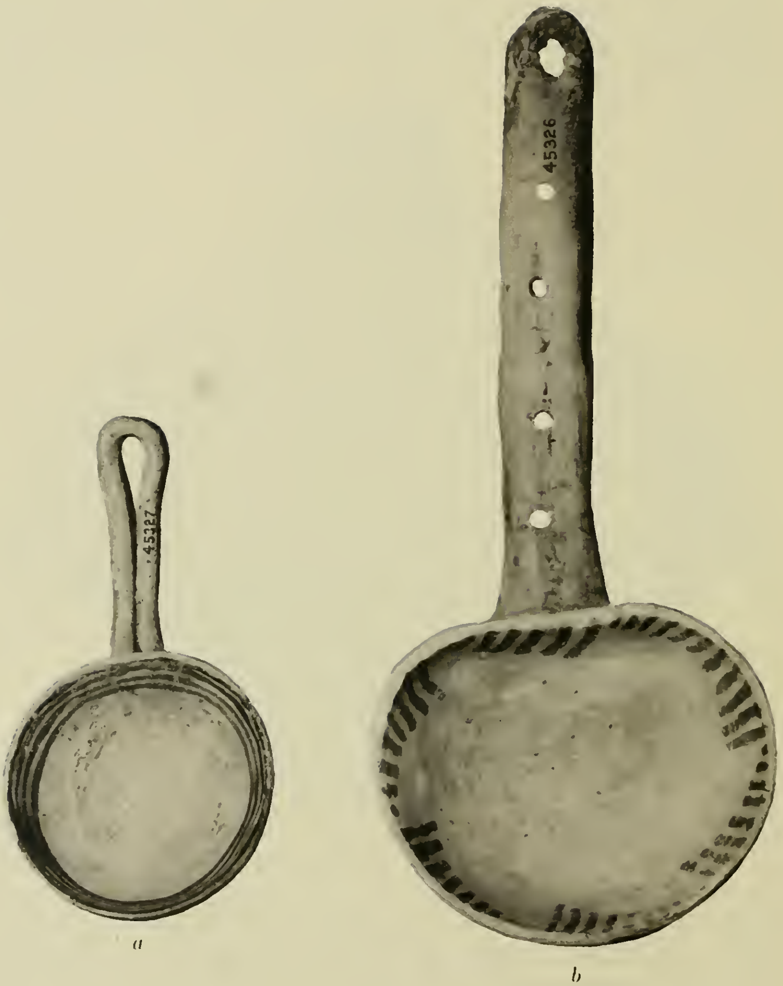
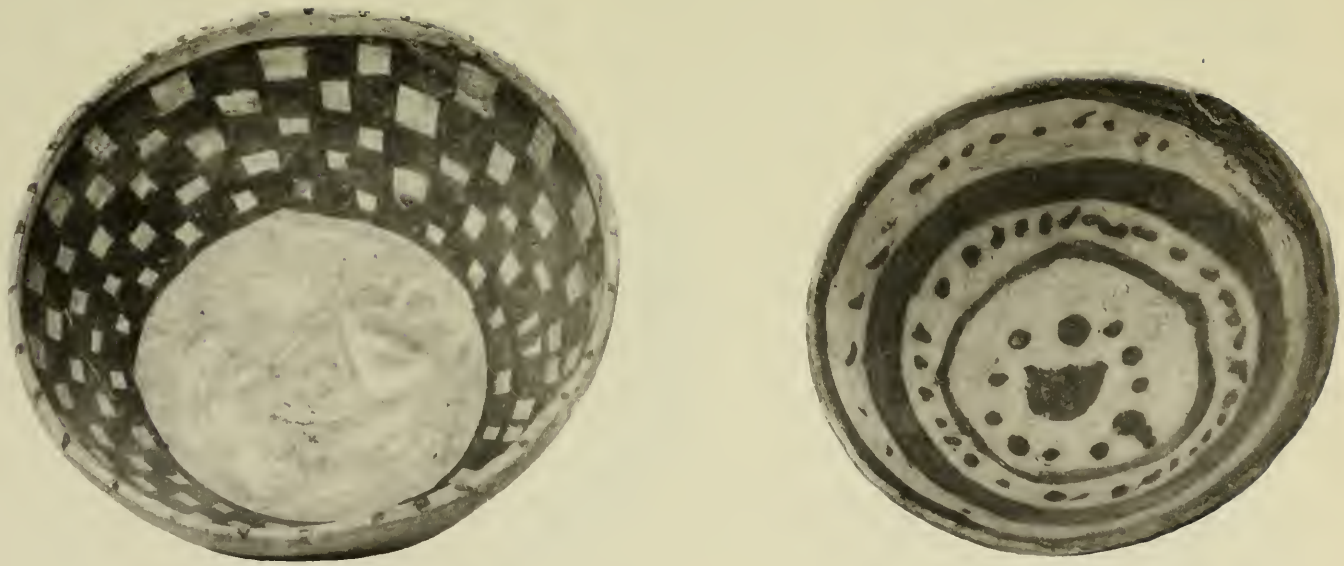


FIG. 30. Mancos black-on-white ladles. Length of *a*, 5 inches.



a b

Fig. 31. Mancos black-on-white bowls. Diameter of a, $5\frac{3}{4}$ inches.

(3) Quartered patterns: interior divided into quarters by two lines intersecting at right angles, half of each line bearing pendent triangles and the other half of each, upthrust triangles (Fig. 35, *b*), or by two rows of polka dots, each row intersecting at right angles.

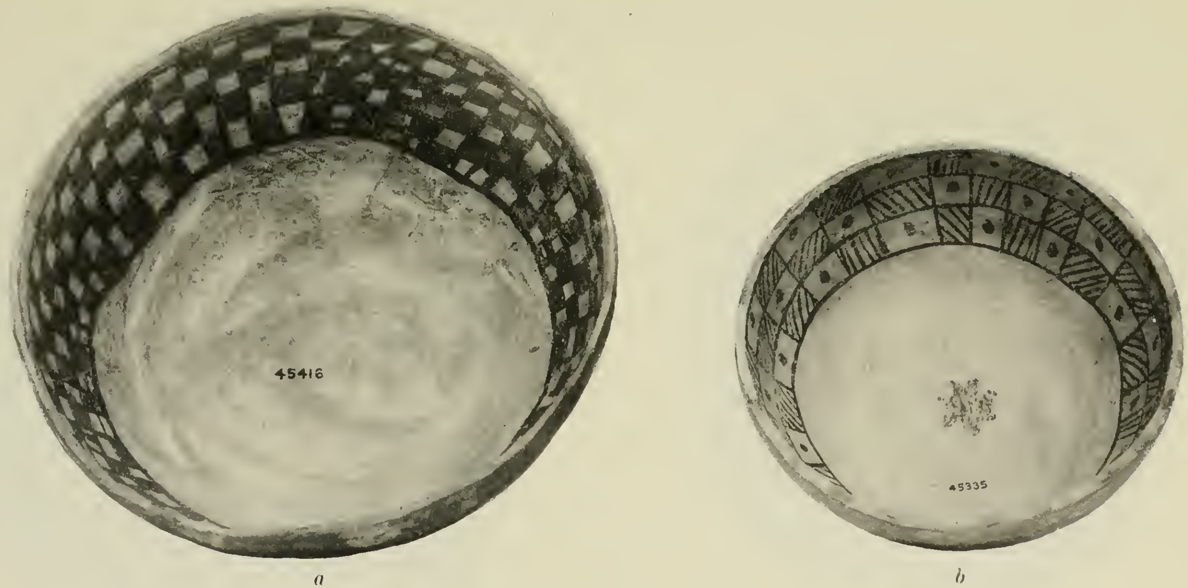
(4) Allover pattern: sets of oblique parallel lines set at nearly right angles to other sets (Fig. 37, *c*).

(5) Aberrant patterns: crudely drawn vertical and oblique lines starting at rim and proceeding towards bottom (Fig. 38, *a*); groups of vertical lines, each line in the group a little longer than the preceding and each starting at rim (Fig. 39, *a*); and pairs of free-standing terraces, one turned up, the other, down, and united at one point at the bases (Fig. 38, *b*).

II. Zone of decoration on jars covers upper portion down to or slightly below shoulder. Designs may be crudely drawn criss-cross lines arranged in panels (Fig. 28); bands of pennant-like triangles whose bases are attached to vertical lines (Plate LXXVII, Fig. 2); or frets and cross-hatching (Fig. 29). I suspect that this last-described design reflects early Chacoan influence, although diagonal hatching in some form may also turn out to be one of the characteristics of Mancos pottery.

Paste.—Gray to blue gray (interior color). The tempering in sixteen sherds, which were microscopically examined by Miss Shepard, consists of sherds crushed very fine. I have megascopically examined about one hundred more sherds and have found that they also seem to be sherd-tempered. Texture in cross section is fairly smooth and even; apparently the paste was thoroughly treated before construction was begun. Degrees of hardness are as follows: 66 per cent have a hardness of 6 (feldspar); 28 per cent, a hardness of 5 (apatite); and 6 per cent, a hardness of 4 (fluorite). In cross section, a dark firing-streak in the center bordered by light marginal streaks on either side may be observed.

Surface Texture.—The texture of bowl exteriors is generally rough; infrequently it is smooth. This smoothness may have been produced by the application of a slip or by scraping. The texture of bowl interiors is always smoother than the exteriors because they were either scraped or scraped and slipped. Occasionally a piece of pottery is imperfectly polished. The remarks concerning bowl exteriors also apply to ladles and jars. Sometimes, the unsmoothed coils remain on the exteriors of bowls. Firing clouds are uncommon.

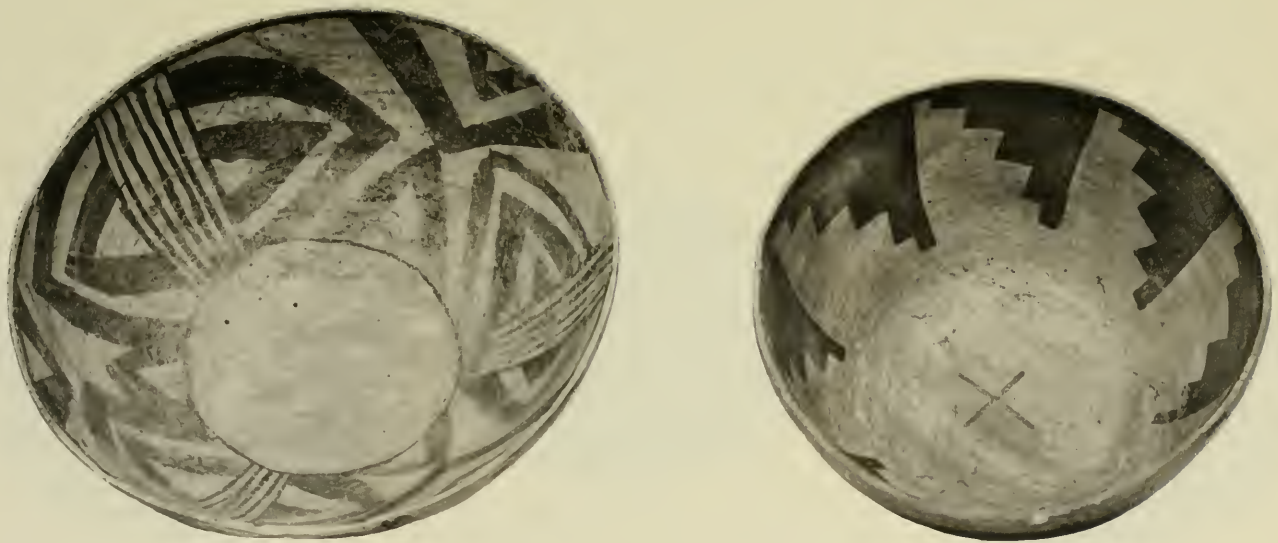


a *b*

Fig. 32. Mancos black-on-white bowls. Diameter of *a*, 8 inches.

a b

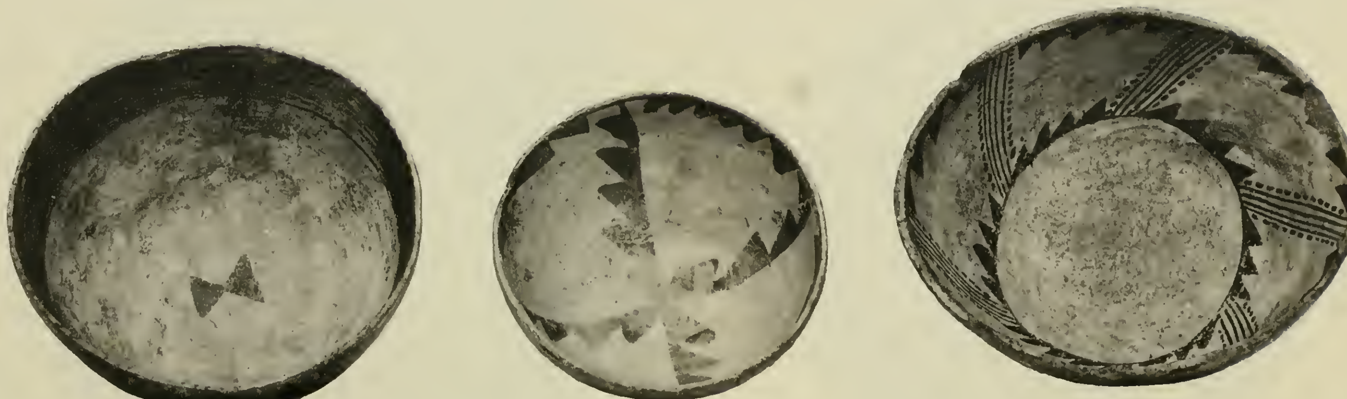
FIG. 33. Mancos black-on-white ladles. Diameter of a, 5 inches.



a

b

FIG. 34. Mancos black-on-white bowls. Diameter of *a*, 7½ inches.



a *b* *c*

FIG. 35. Mancos black-on-white bowls. Diameter of *a*, 7 inches.

a b c

FIG. 36. Mancos black-on-white bowls. Diameter of *a*, 7¼ inches.

Thickness of Body Wall in Cross Section.—The thickness in cross section of the body walls of bowls (including ladle bowls) varies from 5/32 to 3/16 inch; that of jars, from 3/16 to 9/32 inch. The thickness of the walls of both bowls and jars is remarkably uniform although the walls of bowls at the rim may be very slightly thinner (about 1/32 inch).

Rim Forms.—The rims are direct. The lips are thin and sometimes squarish. Abrasions of the lips are so frequent that it is impossible to tell whether they were painted or not. Ticking occurs infrequently on the lips. Outcurved rims are exceedingly rare (Fig. 40).

Chronological Position.—Mancos black-on-white ware was the dominant pottery of Lowry Pueblo.

B. CORRUGATED POTTERY

Although I have been unable to detect any pronounced changes in Mancos black-on-white ware at Lowry Pueblo, I have noted that the accompanying culinary pottery falls into three types: plain corrugated-neck pottery, indented corrugated-neck pottery, and all-over indented-corrugated pottery (Figs. 41, 42, 47). As shown by the graphs (Figs. 43–45) plain corrugated-neck and indented corrugated-neck pottery are more common in the early phases of the pueblo. In other words, there is no one type of culinary pottery which may be associated exclusively with Mancos black-on-white.

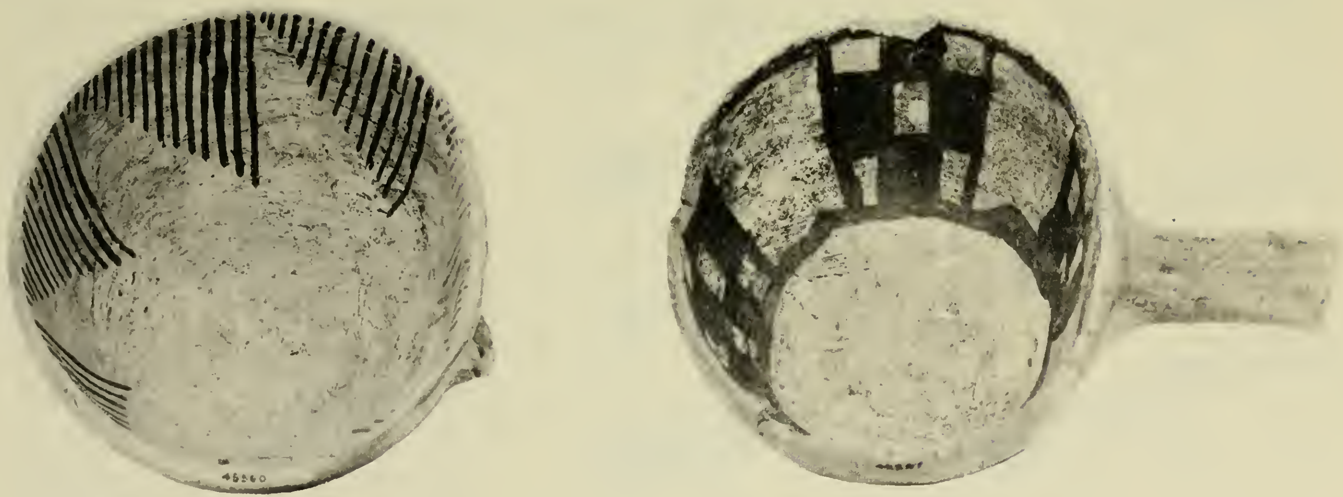
Vessel Shapes and Sizes.—Jars: Only three complete specimens were recovered. On one the greatest diameter at mouth is 3¾ inches, the height, 5 inches; on the second the greatest diameter at mouth is 7¾ inches, the height, 11 inches; on the third the greatest diameter at mouth is 5½ inches, the height, 6 inches. On the first one mentioned above (the smallest) the line of greatest diameter of the body is above the center of the vessel; on the other two it is at about the center of the vessel. The shape of these jars is globular (Figs. 42, 46, *c*); the bottoms, rounded.

Pitchers: Three complete specimens were recovered. On one, the greatest diameter at mouth is 4 inches, the height, 5½ inches; on the second, the greatest diameter at mouth is 4⅜ inches, the height, 6¼ inches; on the third, the greatest diameter at mouth is 5½ inches, the height, 7¾ inches. Contours are wavering; bottoms, rounded; bodies, globular with medium-tall necks. Necks on two specimens rise vertically from shoulder to lip; on the third, the neck rises more or less obliquely from shoulder to lip. Handles on two specimens consist of single fillets of clay and extend from

a *b* *c*

FIG. 37. Bowls. *a*, McElmo black-on-white ware; *b*, *c*, Mancos black-on-white ware. Diameter of *a*, 8½ inches.

FIG. 38. Mancos black-on-white bowls. Diameter of *a*, $5\frac{3}{4}$ inches.



a *b*

FIG. 39. Mancos black-on-white ladles. Diameter of *a*, 4½ inches.

shoulder to a point just below rim; on the third, the handle is made up of three fillets of clay welded together and it extends from a point just above the shoulder to the rim (Fig. 41).

Paste.—Interior color, when not impregnated with carbon, is gray to blue gray. Megascopic examination shows tempering to be composed of coarse grains of crushed rock (quartzite?); the particles are much coarser than those in the painted pottery. Texture in cross section is coarse and uneven; dark firing-streaks, which are so common in painted ware, are almost entirely lacking. Hardness ranges from 4 to 5.

Surface Finish.—Plain corrugated, with coils which are rather wide, suggestive of banding, and which overlap; plain corrugated, with fine coils which overlap; wavy and indented-corrugated; and indented-corrugated. Where the coils have been smoothed away the surfaces are fairly rough. The corrugations on plain corrugated-neck pottery and on indented corrugated-neck pottery are, as the name indicates, confined to that portion of the vessel above the shoulder.

Thickness of Body Wall in Cross Section.—Thickness varies from 7/16 inch to ¼ inch and is remarkably uniform throughout wall area of both jars and pitchers.

Rim Forms.—The rims on the jars are sharply outcurved; on the pitchers, they are nearly direct or only gently outcurved.

STRATIGRAPHY

STRATIGRAPHIC TESTS

Only three areas suitable for making stratigraphic tests were located. These areas are Rooms 8 and 28, and a refuse area west of Rooms 4 and 28. It is entirely possible that there may be other, undetected refuse sections, since approximately only one-half of Lowry Pueblo has been investigated.

The methods used in making these tests were not so thorough as they should have been; but, despite this fault, fairly good results have been obtained.

No common horizontal base line was established, partly because I did not realize in advance that the fill of Rooms 8 and 28 consisted of ashes and general refuse and partly because such a base line would not have helped correlate the various levels of these three dumps. In any event, I felt that I could always fall back on the base line which was used in making the topographic survey.

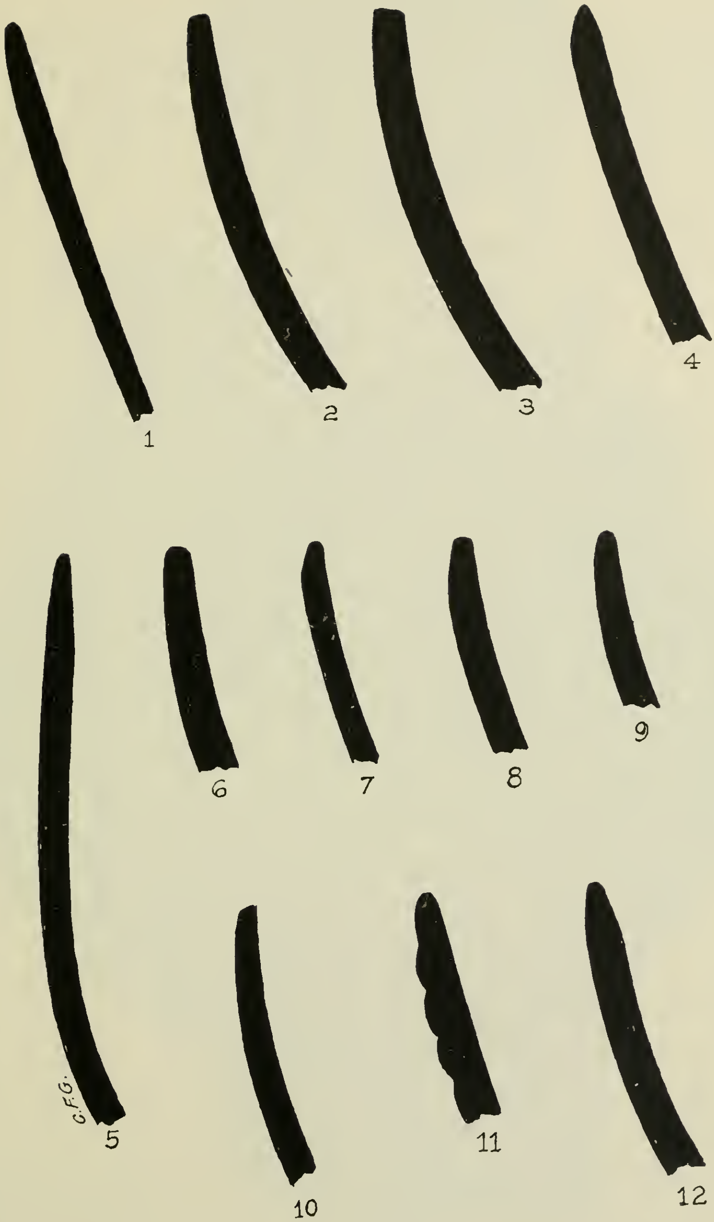


FIG. 40. Mancos black-on-white bowl rim profiles.

FIG. 41. Corrugated-neck pitchers. Height of a, $6\frac{1}{4}$ inches.

Instead, therefore, arbitrary divisions or layers of a given thickness were settled upon (see tables accompanying graphs for thickness of divisions). These divisions were measured down from a fixed point on the nearest wall. Sherds were collected within each

FIG. 42. Jar. Indented-corrugated ware. Height, 11 inches.

division, sacked, and labeled as coming from "1st ft.," "2nd ft.," and so on. They were not washed in the field, but were shipped to the Museum and were there cleaned and classified.

I include herewith a series of three graphs and three tables for the refuse areas previously mentioned (Figs. 43–45; Plates LXXVIII–LXXXII). These graphs indicate the vicissitudes of

Number and Kinds of Sherds and Approximate Percentages for Room 8

Number of Sherds

Cut numbers:[1] Wares	1	2	3	4	5	6[2]	7	8	9	10
Lino gray	0	0	0	0	0	0	0	20	12	10
Undecorated, slipped	0	0	0	0	0	0	0	0	12	0
Mancos black-on-white	4	12	14	28	48	26	26	14	12	8
Wingate black-on-white	12	12	10	16	18	16	24	2	2	2
McElmo black-on-white	26	30	24	10	14	0	0	0	0	0
Mesa Verde black-on-white	16	10	0	0	0	0	0	0	0	0
Plain corrugated-neck	0	0	0	5	10	12	10	11	20	30
Indented corrugated-neck	0	0	0	5	6	8	8	5	16	10
Indented-corrugated (all over)	80	92	70	36	28	14	12	8	6	0
Black-on-red	0	0	0	0	4	0	0	0	0	0
Tusayan polychrome	4	4	0	0	0	0	0	0	0	0
Black Mesa black-on-white	0	0	0	4	2	2	4	4	4	0
Tusayan black-on-red	0	0	0	6	0	6	0	0	0	0
Totals	142	160	118	110	130	84	84	64	84	60

Approximate Percentages

Cut numbers:[1] Wares	1	2	3	4	5	6[2]	7	8	9	10
Lino gray	0	0	0	0	0	0	0	31	14	17
Undecorated, slipped	0	0	0	0	0	0	0	0	15	0
Mancos black-on-white	3	7	12	25	37	31	31	22	14	13
Wingate black-on-white	8	7	8	15	14	19	29	3	2	3
McElmo black-on-white	18	19	20	9	11	0	0	0	0	0
Mesa Verde black-on-white	11	6	0	0	0	0	0	0	0	0
Plain corrugated-neck	0	0	0	4	7	14	12	17	24	50
Indented corrugated-neck	0	0	0	4	5	10	9	8	19	17
Indented-corrugated (all over)	57	58	60	33	21	17	14	13	7	0
Black-on-red	0	0	0	0	3	0	0	0	0	0
Tusayan polychrome	3	3	0	0	0	0	0	0	5	0
Black Mesa black-on-white	0	0	0	4	2	2	5	6	0	0
Tusayan black-on-red	0	0	0	6	0	7	0	0	0	0
Totals	100	100	100	100	100	100	100	100	100	100

[1] Cuts represent strata each 1 foot thick and are numbered from top (cut 1) downward (cut 10 being the lowest). Cuts 7 to 10 were below floor level.
[2] Floor level.

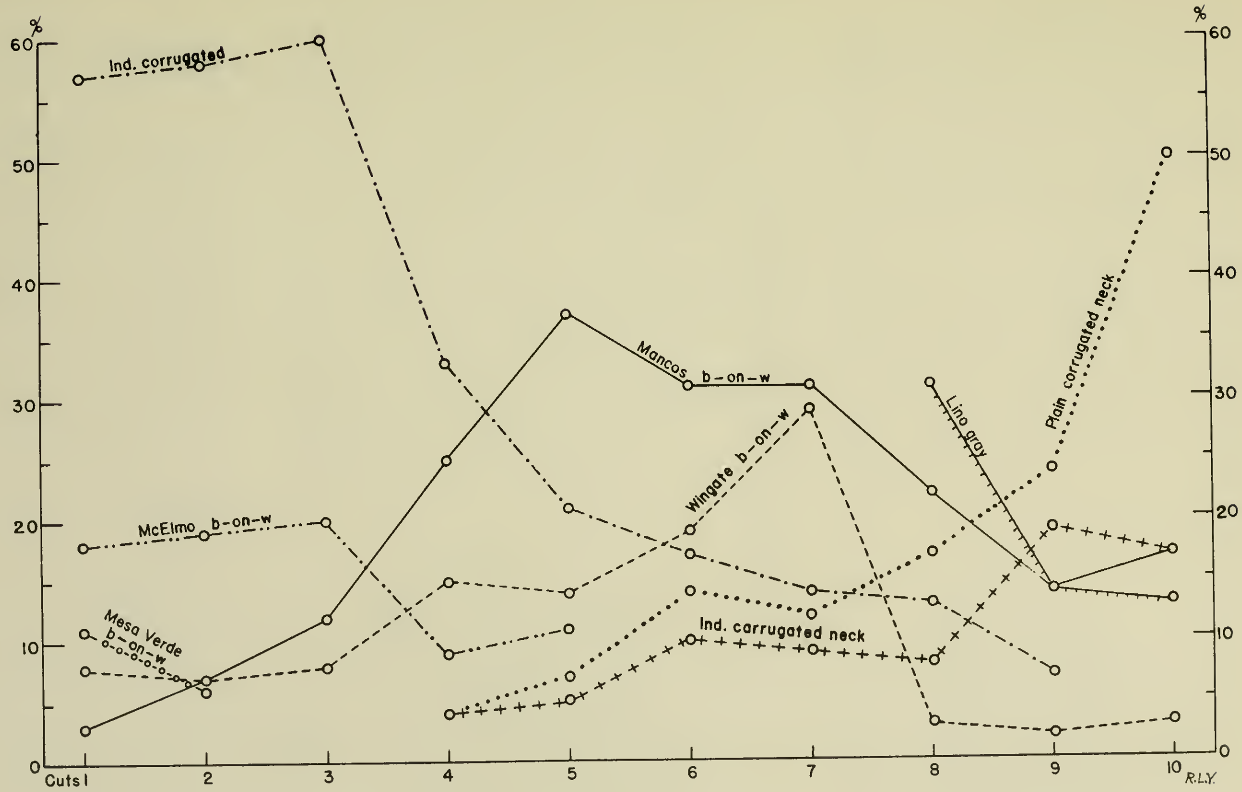


FIG. 43. Graph representing distribution (in percentages) of the principal pottery types found in the successive strata in Room 8.

NUMBER AND KINDS OF SHERDS AND APPROXIMATE PERCENTAGES
FOR ROOM 28

Cut numbers[1]	1	2	3	4	1	2	3	4
WARES	NUMBER OF SHERDS				APPROXIMATE PERCENTAGES			
Lino gray	0	0	0	20	0	0	0	42
Lino black-on-gray	0	0	0	6	0	0	0	12
Mancos black-on-white	0	20	70	2	0	17	27	4
Wingate black-on-white	8	8	26	0	8	7	10	0
McElmo black-on-white	32	30	14	0	33	25	5	0
Plain corrugated-neck	0	0	48	12	0	0	18	25
Indented-corrugated (all over)	54	52	88	0	56	44	34	0
Black Mesa black-on-white	0	8	14	0	0	7	6	0
Tusayan black-on-white	2	0	0	0	3	0	0	0
Wingate black-on-red	0	0	0	8	0	0	0	17
Totals	96	118	260	48	100	100	100	100

[1] Cuts represent strata each 2 feet thick and are numbered from the top (cut 1) downward (cut 4 being the lowest).

NUMBER AND KINDS OF SHERDS AND APPROXIMATE PERCENTAGES
FOR REFUSE AREA WEST OF ROOMS 4 AND 28

Cut numbers[1]	1	2	3	4	1	2	3	4
WARES	NUMBER OF SHERDS				APPROXIMATE PERCENTAGES			
Lino gray	0	0	0	20	0	0	0	9
Lino black-on-gray	0	0	0	10	0	0	0	4
Undecorated, slipped ware	0	0	0	14	0	0	0	6
Mancos black-on-white	60	36	40	58	20	18	25	26
Red Mesa black-on-white	0	4	0	16	0	2	0	7
Wingate black-on-white	22	32	30	20	7	16	19	9
McElmo black-on-white	24	6	0	2	7	3	0	1
Plain corrugated-neck	0	40	40	38	0	20	25	17
Indented corrugated-neck	34	0	0	0	11	0	0	0
Indented-corrugated (all over)	118	80	20	18	39	40	12	8
Sunset redware	4	0	0	0	1	0	0	0
Wingate black-on-red	0	0	20	18	0	0	13	8
Montezuma red-on-orange	0	0	4	0	0	0	2	0
Black Mesa black-on-white	34	2	6	12	11	1	4	5
Tusayan black-on-white	8	0	0	0	3	0	0	0
Tusayan polychrome	4	0	0	0	1	0	0	0
Totals	308	200	160	226	100	100	100	100

[1] Cuts represent strata each 2 feet thick and are numbered from the top cut (cut 1) downward (cut 4 being the lowest).

only the pottery which occurred most frequently and do not register occasional or "foreign" types, which, because of their extreme paucity, are not regarded as important. Furthermore, these graphs embody more than the life span of the Pueblo proper; they embrace, rather, the entire time range of this site, since stratigraphic tests were made in levels from 2 to 4 feet below wall foundations.

As a matter of record, sherds were collected by levels from each excavated room. For the sake of brevity, however, I include no graphs of these records, but only tables showing numbers and

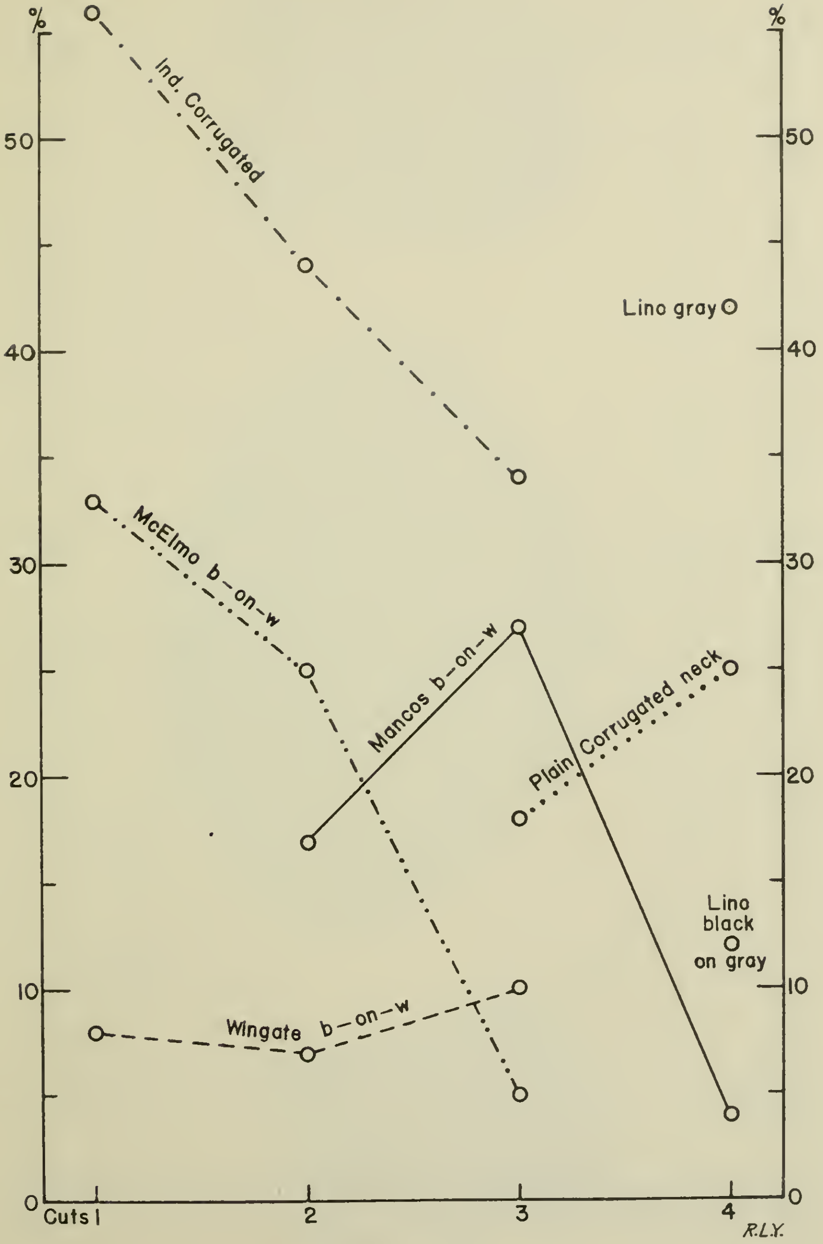


FIG. 44. Graph representing distribution (in percentages) of the principal pottery types found in the successive strata in Room 28.

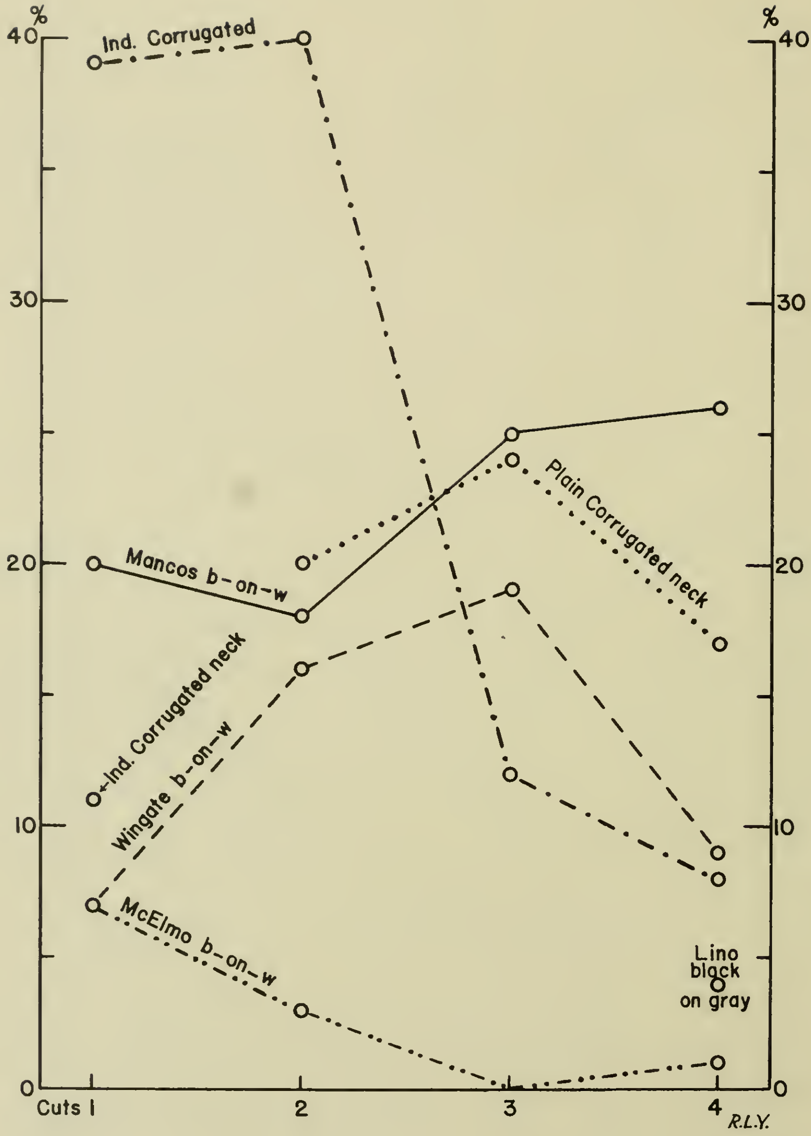


FIG. 45. Graph representing distribution (in percentages) of the principal pottery types found in the successive strata in the refuse area west of Rooms 4 and 28.

FIG. 46. Undecorated pottery. *a*, *b*, Unpainted pitcher and bowl; *c*, Plain corrugated-neck jar. Height of *a*, 4¾ inches.

Number and Approximate Percentages of Sherds
From Floor Levels

Wares	Room 4 No.	Room 4 %	Room 5 No.	Room 5 %	Room 10 No.	Room 10 %	Room 11 No.	Room 11 %	Room 12 No.	Room 12 %	Room 13 No.	Room 13 %
Lino gray	..	..	..	..	..	..	..	..	..	..	..	..
Lino black-on-gray	..	..	..	..	..	..	..	..	..	..	..	..
Undecorated, slipped ware	..	..	..	..	..	..	..	..	..	..	..	..
Mancos black-on-white	18	27	4	13	16	42	9	22	1	9	7	18
Red Mesa black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Wingate black-on-white	2	3	5	16	4	10	10	24	1	9	6	17
McElmo black-on-white	4	6	1	4	..	..	7	17	..	..	10	26
Mesa Verde black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Plain corrugated-neck	..	..	10	32	10	27	..	..	1	9	..	..
Indented corrugated-neck	5	8	..	..	..	..	..	..	6	55	..	..
Indented-corrugated (all over)	28	42	6	19	8	21	14	34	..	..	7	18
Sunset redware	..	..	..	..	..	..	..	..	..	..	..	..
Wingate black-on-red	..	..	4	13	..	..	..	..	..	..	..	..
Montezuma red-on-orange	..	..	1	3	..	..	..	..	..	..	..	..
Black Mesa black-on-white	9	14	..	..	..	..	..	..	2	18	8	21
Tusayan black-on-white	..	..	..	..	..	..	1	3	..	..	..	..
Tusayan black-on-red	..	..	..	..	..	..	..	..	..	..	..	..
Tusayan polychrome	..	..	..	..	..	..	..	..	..	..	..	..
Totals	66	100	31	100	38	100	41	100	11	100	38	100

percentages of sherds recovered from floor levels (pp. 108–111). Inasmuch as the three graphs presented give all the data of growth and decline of pottery types, more graphs would be duplication.

I have tried, without marked success, to work out a correlation between building periods and pottery collected from floors. This lack of success may be due to carelessly collected data; but I believe it is due, rather, to the fact that Lowry Pueblo was erected in a very short period of time and that the Pueblo was successively abandoned, reoccupied, and modified several times. All these factors naturally tend to confuse the data and to render useless any conclusions based exclusively on ceramic sequences. Instead, I have relied upon wall abutments and bondings.

NUMBER AND APPROXIMATE PERCENTAGES OF SHERDS FROM FLOOR LEVELS—*Continued*

Wares	Room 15 No.	Room 15 %	Room 16 No.	Room 16 %	Room 17 No.	Room 17 %	Room 18[1] No.	Room 18[1] %	Room 19 No.	Room 19 %	Room 20 No.	Room 20 %
Lino gray	..	..	..	..	..	..	..	..	..	..	..	..
Lino black-on-gray	..	..	..	..	..	..	..	..	..	..	..	..
Undecorated, slipped ware	..	..	..	..	..	..	..	..	..	..	..	..
Mancos black-on-white	4	16	6	30	2	12	5	19	22	51	2	10
Red Mesa black-on-white	..	..	1	5	..	..	..	..	..	..	..	..
Wingate black-on-white	9	36	5	25	5	29	8	29	3	7	3	15
McElmo black-on-white	..	..	..	..	..	..	2	7	3	7	..	..
Mesa Verde black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Plain corrugated-neck	7	28	2	10	..	..	..	..	..	..	..	..
Indented corrugated-neck	..	..	..	..	..	..	..	..	5	12	6	30
Indented-corrugated (all over)	5	20	1	5	..	..	9	33	4	9	5	25
Sunset redware	..	..	..	..	..	..	..	..	..	..	..	..
Wingate black-on-red	..	..	..	..	2	12	..	..	..	..	3	15
Montezuma red-on-orange	..	..	4	20	2	12	..	..	4	9	..	..
Black Mesa black-on-white	..	..	1	5	1	6	2	8	2	5	1	5
Tusayan black-on-white	..	..	..	..	..	..	1	4	..	..	..	..
Tusayan black-on-red	..	..	..	..	5	29	..	..	..	..	..	..
Tusayan polychrome	..	..	..	..	..	..	..	..	..	..	..	..
Totals	25	100	20	100	17	100	27	100	43	100	20	100

[1] Over Kiva D.

REFUSE AREAS

Room 8 served first as a dwelling room and later, as a place for dumping refuse. This refuse consisted of some broken pottery and of approximately 1,500 cubic feet of wood ash. It is estimated that about 3,000 tons of wood (pinyon and juniper) must have been consumed to produce this amount of ash. Room 28 was erected upon refuse material and was also later used as a dump. The fill was made up of ash and a few potsherds. The refuse area west of Rooms 4 and 28 was located west of the Pueblo, which is not customary for this area, and served, in early times, as a cemetery.

Unfortunately, in comparison with other large sites, such as Pecos or Pueblo Bonito, the rubbish heaps of Lowry Pueblo were

NUMBER AND APPROXIMATE PERCENTAGES OF SHERDS FROM FLOOR LEVELS—*Continued*

Wares	Room 21 No.	Room 21 %	Room 27 No.	Room 27 %	Room 32 No.	Room 32 %	Room 33 No.	Room 33 %	Room 34 No.	Room 34 %	Room 35 No.	Room 35 %
Lino gray	..	..	..	..	..	..	32	24	..	..	..	..
Lino black-on-gray	..	..	..	..	..	..	..	..	..	..	1	2
Undecorated, slipped ware	..	..	..	..	..	..	..	..	..	..	4	6
Mancos black-on-white	4	12	3	12	4	45	6	4	28	32	19	29
Red Mesa black-on-white	..	..	..	..	..	..	..	..	..	..	3	4
Wingate black-on-white	6	15	3	12	3	33	7	5	24	27	14	21
McElmo black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Mesa Verde black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Plain corrugated-neck	..	..	5	22	..	..	54	39	..	..	5	7
Indented corrugated-neck	4	12	..	..	..	..	..	..	..	..	..	..
Indented-corrugated (all over)	17	46	13	54	..	..	15	11	31	36	17	26
Sunset redware	..	..	..	..	..	..	3	2	..	..	..	..
Wingate black-on-red	..	..	..	..	..	..	..	..	..	..	..	..
Montezuma red-on-orange	..	..	..	..	..	..	..	..	3	3	..	..
Black Mesa black-on-white	..	..	..	..	2	22	18	13	1	2	3	5
Tusayan black-on-white	6	15	..	..	..	..	..	..	..	..	..	..
Tusayan black-on-red	..	..	..	..	..	..	..	..	3	2	..	..
Tusayan polychrome	..	..	..	..	..	..	..	..	..	..	..	..
Totals	37	100	24	100	9	100	138	100	87	100	66	100

not of any great depth nor do they reflect any great span of time; and, even worse, the Lowry rubbish heaps and the room debris produced remarkably few sherds. Therefore, I have tried to be cautious in drawing conclusions which are of necessity based on a comparatively small series of sherds.

DISCUSSION AND SUMMARY OF LOWRY POTTERY

Judging from the stratigraphic data, Mancos black-on-white ware appeared at Lowry during the decline of Lino gray and Lino black-on-gray pottery (Basket Maker III and Pueblo I). This evidence might indicate that these two wares were the parents of Mancos black-on-white and perhaps that is true.

NUMBER AND APPROXIMATE PERCENTAGES OF SHERDS FROM FLOOR LEVELS—*Concluded*

Wares	Room 36 No.	Room 36 %	Room 37 No.	Room 37 %	Kiva C No.	Kiva C %	Kiva D No.	Kiva D %	Kiva F No.	Kiva F %	Great Kiva[1] No.	Great Kiva[1] %
Lino gray	..	..	..	..	..	..	..	..	..	..	..	..
Lino black-on-gray	..	..	..	..	..	..	..	..	..	..	2	1
Undecorated, slipped ware	15	12	..	..	..	..	..	..	..	..	..	..
Mancos black-on-white	41	34	4	31	15	56	2	20	19	14	43	22
Red Mesa black-on-white	8	7	..	..	2	7	..	..	1	1	..	..
Wingate black-on-white	20	17	1	7	8	29	6	60	54	38	5	3
McElmo black-on-white	2	2	..	..	1	4	..	..	..	..	30	15
Mesa Verde black-on-white	..	..	..	..	..	..	..	..	..	..	43	22
Plain corrugated-neck	5	4	1	8	..	..	..	..	..	..	..	..
Indented corrugated-neck	..	..	4	31	..	..	..	..	..	..	5	3
Indented-corrugated (all over)	24	20	3	23	..	..	..	..	59	43	22	9
Sunset redware	..	..	..	..	..	..	..	..	..	..	..	..
Wingate black-on-red	..	..	..	..	..	..	..	..	..	..	..	..
Montezuma red-on-orange	..	..	..	..	..	..	..	..	..	..	..	..
Black Mesa black-on-white	4	4	..	..	1	4	2	20	1	1	50	25
Tusayan black-on-white	..	..	..	..	..	..	..	..	..	..	..	..
Tusayan black-on-red	..	..	..	..	..	..	..	..	4	3	..	..
Tusayan polychrome	..	..	..	..	..	..	..	..	..	..	..	..
Totals	119	100	13	100	27	100	10	100	138	100	200	100

[1] Latest floor.

However, the hypothesis just stated is not entirely convincing. This relationship, if it exists, is not very clear, inasmuch as the designs of the Lowry-Mancos ware do not reflect any pronounced Basket Maker III decorative traits. Of course, it is possible that the Lowry-Mancos black-on-white ware had already progressed beyond the state of close similarity and that an affinity might be found at a smaller and a more briefly occupied site.

But it seems to me that Mancos black-on-white evinces closer ties with early Chacoan pottery traits which were trickling northward from the area between Gallup and Shiprock, New Mexico. This relationship cannot be proved at present, but, when examining thousands of sherds gathered from the Gallup-Shiprock region and

now stored at Gila Pueblo, Globe, Arizona, I was struck with the similarities in technique and design between Mancos black-on-white and the wares from northwestern New Mexico. Indeed, when classifying the sherds from Lowry Pueblo, I sometimes found it difficult to decide whether a sherd was Mancos black-on-white, as defined above, or Chacoan.

Such ambiguity might lead one to doubt the validity of the Mancos classification as separate from the Chacoan.

In defense of my thesis of a common southern origin, however, I can only state that, to me, Mancos black-on-white ware merely manifests certain early, more or less unspecialized ceramic tendencies which emanated from the Little Colorado-Puerco-Shiprock area. This marked southern influence on northern pottery (and architecture?) has already been commented on by Kidder (1924, pp. 55–56, 68). In this northern area (southwestern Colorado and southeastern Utah) the potters retained certain southern traits which are called Chacoan and perhaps originated others, thereby producing what is now termed Mancos black-on-white ware. It is entirely probable that McElmo black-on-white (formerly known as Proto-Mesa Verde) grew out of this fusion of early, undifferentiated Chacoan ceramic traits with local ceramic specializations.

In further defense and strengthening of my thesis (that is, the northward diffusion of southern complexes), I call attention to the occurrence at Lowry Pueblo of Chacoan masonry and a Great Kiva, a type of building which is associated, so far as is known, only with Chaco culture.

I do not mean to imply that there was any exodus from Chaco Canyon northward of either peoples or cultural traits; for I believe that the sites found there represent the remains of a highly specialized offshoot of generalized culture trends which were simultaneously diffusing northward and eastward from a Little Colorado-Puerco focus. This northward extension of southern tendencies brought about the peculiar construction not only of Lowry Pueblo, but probably also of Yucca House (near Cortez, Colorado), Pipe Shrine House (Mesa Verde National Park), Yellow Jacket Spring Ruin (near Yellow Jacket, Colorado), and many other unnamed sites.

The graphs presented register the rise and ebb of various wares from the time the site was first inhabited until it was deserted. They also demonstrate that:

(1) All-over indented-corrugated pottery increases steadily from zero or almost zero at the base of the refuse areas to 40 or 50 per cent;

(2) Basket Maker III and Pueblo I pottery represent a fair percentage of the total sherds at the bottom of the refuse heaps and thereafter quickly decline to zero;

(3) Mancos black-on-white is present from earliest times, rising and then gradually decreasing in percentage;

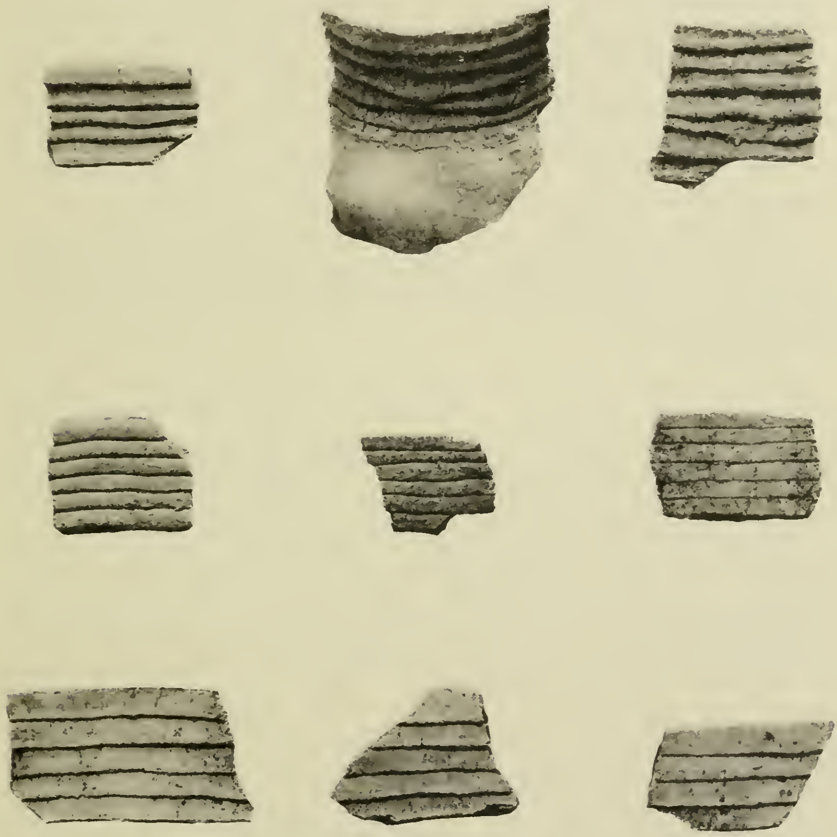


FIG. 47. Potsherds of plain corrugated ware.

(4) Chacoan pottery, as represented by Wingate black-on-white, is important and follows more or less closely the vicissitudes of the Mancos pottery;

(5) McElmo black-on-white rises gradually from nearly zero in the lower or lowest portions of the refuse areas and *precedes* Mesa Verde black-on-white (Fig. 43).

The graphs as well as the appended tables clearly indicate the abundance of pottery from the Chaco branch (that is, Red Mesa and Wingate black-on-white) and the presence of wares from the Kayenta area.

I doubt whether the Kayenta culture influenced Lowry Pueblo either architecturally or ceramically; but I have no doubt whatsoever concerning the influence of the Chaco branch on Lowry architecture and ceramics. As stated elsewhere (Chapters II and VI), some of the pueblo contains typical Chacoan masonry as well as rooms, the dimensions of which are certainly similar to those of the larger Chacoan pueblos. Whether or not the Red Mesa and Wingate black-on-white wares were actually manufactured at Lowry and not introduced through trade, can not be decided without a petrographic analysis of the pottery—a task not yet started.

The graph (Fig. 43) for Room 8 indicates that the refuse fortuitously located under the floor is older than that of the lowest stratum in either Room 28 (Fig. 44) or the refuse area west of Rooms 4 and 28 (Fig. 45).

VI. LOWRY RUIN AS AN INTRODUCTION TO THE STUDY OF SOUTHWESTERN MASONRY

BY

LAWRENCE ROYS

In piecing together the prehistory of the American Southwest, the study of its architecture has played an important part. Naturally, general design has ranked first in the field of architectural analysis, and the treatment of detail from the esthetic point of view appears to hold second place. Somewhat in contrast with the attention given to these features is the comparative lack of study and effort expended upon the technique that was used by the masons who actually quarried and laid the stone.

This seeming neglect of one branch of architecture has not been without cause. Recently, new methods and evidence have demonstrated that the well-known pre-Columbian ruins show a rapid architectural development covering a period when Southwestern culture was coming into full flower; and it is natural that such discoveries should have temporarily crowded aside less spectacular techniques. Also, and more important, the fluent character of the general design and the craftsmanship during this period of development has made analysis difficult. These builders were flexible enough in their methods to respond to variation of environment, notwithstanding the fact that they showed at least normal persistence in maintaining habits and customs over long periods; and it is no easy task to judge which traits in the mason's craft are due principally to environment, and which are to be accredited to guild knowledge slowly accumulated and transmitted from master to apprentice. Here the archaeologist faces a truly difficult problem.

Since the progress in excavating Lowry ruin emphasized the situation just outlined, it seemed desirable that this archaeological project should include an attempt to analyse the mason's technique as exemplified there. This attempt was made, and as a first step a method was devised for rather exactly observing and recording details as to the manner in which stone was shaped and laid in mud-mortar. We believe that this analytical work and the report of it that follows is a conservative and constructive step forward.

As might be expected, we next tried to compare the techniques of Lowry ruin with other masonry of the San Juan district in the hope that this comparison would contribute toward the reconstruction

of the historical picture of the Southwest. While it was easy to confirm the close relationship between early Lowry masonry and that in Chaco Canyon and at Aztec, we can claim little success as to the last-mentioned objective. We soon found that there were so few descriptions of Southwestern masonry on record (even including that by Hawley, 1934) that a comparative study was out of the question. Due to the lack of data we were obliged to drop this objective. In this chapter, however, will be given an account of our manner of working and of our preliminary deductions. We hope that these will be of use to other observers. But first we shall present, in formal fashion, a study of the situation and a comparison of the two most important types of masonry found at Lowry ruin.

Masonry Analysis at Lowry Ruin

The appearance of a primitive wall of any sort is an invitation to the student to speculate upon its anthropological meaning. At its poorest, a wall represents the solution of a definite mechanical problem; while in its better and more advanced forms it may easily illustrate a number of the principles that anthropologists are trying to clarify. It may be of mud, of stone, of wood, or of a combination of these elements; and it is fundamentally so simple a device that its structure sometimes indicates little of interest. However, it usually so happens that there are many possible ways of combining the materials at hand into a wall. Thanks to this situation, it is often possible to see in the technique of wall-building a reflection of the mental traits of the builders, and in some cases we can go further and accurately trace cultural history, somewhat as has been done with pottery in recent years.

It would be a mistake to imply that most of the principles of pottery study can be taken over bodily by the masonry student. In wall-building, the materials at hand usually showed greater variation than the potter's clay of a region, and consequently there was less chance for masonry technique to become stereotyped. On the other hand, the primitive mason was unconsciously held within certain limits by the mechanical principles of stability, strength of materials, and the necessity for an adequate area of cross section to support the weight borne (for discussion of this last problem of bearing area, see Roys, 1934). Also he was influenced, probably more consciously, by the factors that affected the tightness and permanence

of his structures. These things made him realize that change was apt to end in failure. He was urged on by the necessity of utilizing available material and helped by a slow native inventiveness, and yet was held back by all the usual forces of conservatism. Between these opposing influences, he unconsciously worked out the course of his masonry development.

As we apply such general principles to the San Juan drainage basin of the American Southwest, we immediately meet with examples of masonry that arouse our admiration, and with contrasts in methods of using stone and mud that challenge us for an explanation. Outstanding in this archaeological field is the highly specialized use of slablike stones found at Chaco Canyon and Aztec in New Mexico. We find there a fully developed style that not only embodies certain structural principles but also strongly emphasizes them in the external appearance of the walls. Chacoan masonry is truly beautiful and was laid by master workmen. Its character is so pronounced that it is recognizable wherever it appears even in modified form, and no critic has yet expressed doubts of the close relationship of the peripheral examples to the central stem. Wherever Chaco masonry appears, the archaeologist can safely say that the people who built in such a manner were culturally related to the master builders of Chaco Canyon.

In contrast to this peculiar technique in stone work are many examples of masonry in the San Juan district that are specialized only to a very moderate degree. Nevertheless, even such examples show tendencies toward specialization that are too consistent to be accidental, and seem to point out probable cultural relationships. Some of them are distinguished by earmarks which render classification comparatively easy, although none compare with Chaco in this respect. Others are hard to classify, even when the observer stands before the actual wall in the field; and many seem to defy analytical description and satisfactory note-book recording. However, these evidences are far too valuable to be overlooked, and it is important that a method of record and classification be worked out that allows the student to competently record, sort, and compare material. To this task, the Field Museum Expedition addressed itself during the summer of 1934, and the results are formulated in the following pages.

Of course, a study of the manner of making observations is a different matter from historical and archaeological interpretation of accumulations of data. The former is merely a means to an end, but

certainly is far from unimportant. In writing this chapter, I am therefore emphasizing every factor that I can which would seem to awaken interest in observational technique; and I think I am fully justified in doing this, as up to the present time the many other phases of Southwestern culture have crowded far ahead of the details of its masonry. In this particular branch of investigation, our crying need is for workable data; and as soon as these accumulate in reasonable quantity, much of the story of masonry development in the Southwest will tell itself.

The use of Lowry ruin for this study was very fortunate. To find two clearly distinct types of technique almost side by side in the same pueblo was a great advantage, and it enabled us to proceed much more rapidly and surely than we could possibly have done, had we been obliged to compare two or more sites far apart. Had we happened to commence this work of masonry analysis at a ruin where distinct types were absent, and only blends and sub-types were evident, we could easily have spent a full season in groping toward premises and conclusions which were clearly evident at Lowry ruin after a few days of study. Furthermore, Lowry offered some obscure modifications and a number of examples that were disguised by later repair, and these served the purpose of testing the validity and workability of our conclusions and our methods. In looking back over the archaeological situation pictured by this ruin, I now see that Dr. Martin's hope that positive results might easily follow an intensive masonry analysis was based upon promising evidence and was far from a wild guess.

The positive results consist in the identification of two different and distinct types of masonry. One of these types is a highly specialized technique in quarrying stones and building them into walls—so highly specialized that we believe that wherever it may be found we can reasonably consider it as evidence of a single basic culture. This is the technique that is found in its most perfected form at Chaco Canyon and at Aztec, although it did not necessarily originate there.

The second type might be called non-Chaco and is not so highly specialized. We cannot, therefore, conclusively attribute it to a single culture, although it may valuably confirm other methods of linking ancient peoples or events concerning them. Its occurrence strongly suggests that its users were not members of the Chaco culture. We are convinced that further study of this general type will result in the isolation and identification of sub-types which will certainly be valuable in pointing out tendencies, and it is probable that

at least one or two of these sub-types will prove to be highly enough specialized to link together positively the peoples that used them.

Below is given a detailed description of each of the two types, and this is followed by a more easily visualized summary arranged in comparative form. The summary is given in the hope of encouraging a reader to persevere beyond the intricate descriptions immediately following.

LOWRY CHACO-LIKE MASONRY TECHNIQUE
(Plates XXII–XXVI)

(1) The quarryman loosened flat stones from well-laminated deposits of sandstone and these provided reasonably flat upper and lower horizontal surfaces for each wall stone. In the wall, the stones were practically always laid with these surfaces horizontal. Thicknesses ranged from less than an inch up to 5 inches with an average of about 2½ inches. The length averaged a foot more or less, while the depth varied. Each wall stone had at least one vertical face (intended to serve as the wall face) which was approximately flat and rectangular, and this was sometimes a natural cleavage and sometimes a break made by the quarryman or mason. The remaining vertical sides were very roughly shaped, and less than one stone in four had an approximately rectangular appearance in plan view (looking down upon it).

(2) Subsequent tooling was normally absent in this technique. Of course the stones were crudely broken to size and shape, and possibly some chipping or knocking off of corners was done to make the exposed vertical face appear rectangular. However, the wall stones which we took down and examined were far too rough to be classed as hewn stone. The "dimpling" with a pecking stone that is common on the more block-like masonry of this neighborhood appears only on stones that we consider abnormal to this flat stone technique, and we consequently suspect that such dimpled stones were re-used, after having been quarried and finished for earlier walls by workmen of a different culture.

(3) The coursing was always pronounced. The use of flat slabs of stone invited the mason to build his walls in layers, but it hardly compelled him to pay as much attention to evening his courses as is usually found in this technique. We therefore decided that these masons had, at the time these walls were laid, a distinct "feeling" for coursing, and that this is a characteristic of the culture regardless of the shape of the stones.

(4) The flat stones were always laid in a substantial bed of mud. Varying from 3/8 inch to a full inch in thickness, this averaged fully 3/4 inch. Just as modern brickwork is a specialized technique of embedding flat blocks in a mortar that is much weaker than the blocks, so we found here a technique where slabs of stone are consistently embedded between thick cushions of mud.

(5) The spalls used in this technique were always flat flakes of stone 1/4 to 1/2 inch thick, and from the size of a playing-card down (Fig. 4, *e*). They always had at least one straight side which was laid about flush with the visible face of the wall. These spalls were invariably laid in a peculiar manner. They seldom touched the stone below them or the stone above, but were embedded between cushions of mud above and below just like the wall stones. This mud cushion was usually about a third as thick as the mud cushion mentioned above, but the technique was practically identical. Furthermore, these spalls did not extend back into the wall the full depth of the wall stones, but only about one-quarter as deep, and often less. The spalls were laid in the courses as the wall progressed upward, and were not inserted into the joints after the completion of a part or the whole of the wall. Back of the spalls, the mud cushions just mentioned in Item 4 filled in all the space between the wall stones, and transmitted the load borne by the center of the wall.

(6) The core or hearting of this type of wall was chiefly well-puddled mud, although it might contain more or less stone. Regardless of the proportion of rough broken stone in the core, the laminated nature of the wall (shown on the surface by the distinct courses) was maintained to some extent in the center of the wall. Irregular flat stones horizontally laid in the mud core were usual, while irregular jagged stones that would spoil the coursing were much less usual.

LOWRY BLOCK-LIKE MASONRY TECHNIQUE (NON-CHACO)
(Plates XXVII–XXVIII)

(1) The quarryman furnished the mason with rather block-like stones, and, when seen in the finished wall, these appear to have been roughly squared on all sides. Actually, only the exposed faces were squared; and the sides concealed by mud mortar were left pretty irregular. They ranged from 2 to 5 inches thick ordinarily (with occasional stones 6 or 7 inches thick) and averaged 3 1/2 inches. The thicker stones averaged 10 inches in length and the thin ones were shorter. The plentiful supply and use of smaller stones brought the average thickness down to a lower figure than the photographs suggest.

In contrast to the stones found in Lowry Chaco-like walls, the quarryman took little pains to select stones whose upper and lower surfaces were flat and horizontal. Apparently, a flat rectangular vertical face was his principal objective, and he was content with rough and irregular upper and lower faces. He seems only to have demanded fairly straight upper and lower edges of the visible vertical face. The mason who laid the stones in the wall evidently took over the burden of compensating for crudeness in the quarrying. He even accepted stones whose upper surfaces (supporting the wall above) sloped outward and downward fifteen or twenty degrees from the horizontal, and laid the course on top of them so cleverly that the wall did not slide down this precarious slope.

(2) The visible vertical face of each stone was normally tooled with a pecking stone to approximate flatness—"dimpled," as the operation has been named. The unexposed faces were roughly broken to shape as mentioned above. We found isolated instances of the visible vertical faces being rubbed smooth in addition to the dimpling and this may have been a variation of this technique. However, I suspect that rubbing was an evidence of intrusion, or possibly of re-use of stones from earlier walls. We need more data on this point.

(3) Coursing was usually present to some degree, but it appeared to be only such coursing as was naturally incidental to the use of rectangular-faced blocks, and the crude leveling off of the wall at intervals as at the close of the day's work. I could see no "feeling" for coursing in this technique.

(4) We made a careful analysis of the interior wall construction by unlaying typical portions, and this showed plenty of mud mortar throughout, whose function was primarily to fill the voids, and only secondarily to help carry the load of the wall. Normally there was stone-to-stone contact which transmitted the bulk of the load, either wall stone to wall stone directly, or through a strategically placed spall. The walls were laid according to the technique of dry-laid masonry[1] and would stand up to a considerable extent if the mud filler were entirely washed away.

(5) Two entirely separate classes of spalls were much used in this technique. Within the wall were incorporated jagged stone frag-

[1] "Dry-laid masonry" or "dry masonry" is stone work laid up without any mortar or other filler between the stones, and consequently stone-to-stone contact is found throughout such a wall. In referring to "the technique of dry-laid masonry," we mean that the position of the stones in a wall and the stone-to-stone contact are practically the same as if no mortar was used. This phrasing accurately describes certain types of masonry even though it is actually laid up in mud.

ments of irregular shape that touched both the wall stones above them and those below. These transmitted downward the pressure due to the weight of the wall (as described in the preceding paragraph), and we have called them "true-bearing" spalls. Apparently after the wall was completed, an additional outside coat of mud was applied to the gaps between the wall stones to even up the face of the wall. It was customary to insert in the larger joints a wedge-shaped stone of about the size of one's thumb, after the lump of mud was applied. This wedge did not ordinarily touch the adjoining wall stones, but merely served to swell the mud mortar against the wall stones. We have called these stone wedges "false" spalls (Fig. 4, *d*).

(6) The core or hearting of this type was usually a mass of irregular rock fragments laid in well-puddled mud (i.e. ordinary modern rubble). In unlaying such a wall we generally found that jagged projections from rocks forming the core reached upward and downward in such a way as to discourage the mason from perfecting the tendency toward coursing that was a natural accompaniment of the use of rectangular-faced stones.

SUMMARY

LOWRY CHACO-LIKE

(1) Wall stones were thin slabs from well-laminated ferruginous sandstone deposits. The edge forming visible wall face was straight, but the rest of the stone was very irregular.

(2) The untooled, transverse vertical cleavage of the thin slab was flat enough to form the wall face. Corners of the stone within the wall were left irregular, or crudely broken off.

(3) A pronounced tendency toward laying walls in courses is noticeable.

(4) Each stone was laid in a substantial bed of mud. Consequently, the strength and permanence of the walls were mainly dependent upon the successful use of mud mortar.

(5) The spalls were always flat, thin flakes of stone set in the masonry joints close to the face of the wall. They were laid as the wall progressed upward. These spalls, together with the thin mud cushions embedding them, served as a dam or stop when the wall was built and prevented the thick interior layers from being pressed out.

(6) Throughout the wall core is found the same tendency toward coursing that appears on the outer face of the wall.

LOWRY NON-CHACO OR BLOCK-LIKE

(1) More block-like stones were taken from thicker, calcareous sandstone deposits. One flat rectangular side was to serve as the wall face. The stones buried in the wall were irregularly faced.

(2) The visible faces of many wall stones were dimpled with a pecking stone to approximate flatness. Corners of the stones within the wall were left irregular or crudely shaped.

(3) Such coursing as is found appears to have been purely incidental to the use of rectangular-faced stones.

(4) Mud mortar was invariably used, but its function was primarily to close the voids between the stones, and only secondarily to give strength to the masonry.

(5) Two classes of spalls are found: (*a*) stone fragments which prop the individual wall stones firmly in position regardless of the strength value of the mud mortar; and (*b*) stone wedges that were inserted as spreaders in the lumps of soft mud that were applied after the wall was finished to fill up the joints and even off the wall surface.

(6) The wall core consists of rough rubble irregular vertically as well as horizontally, indicating that the mason had little idea of laying the stones in courses.

These descriptions are slightly generalized to emphasize the types, and to allow them to be visualized. However, they are substantially correct, and the variations from them that we found at Lowry ruin are of subordinate nature.

The classification of masonry purely by description in such elaborate detail is likely to prove a weak method when variations of type are encountered and where blends of technique require reconciliation. I feel that the more difficult problems in this line can only be met successfully if one has a fairly complete insight into the principles involved in the mason's technique. These principles are both ethnological and mechanical. Esthetic and other ethnological values are factors which I cannot and need not discuss, but the situation warrants a closer study of the mechanical principles of wall-building than is to be found easily in archaeological literature. Here, I take the liberty of inserting such a study with the idea of its serving as groundwork for the more intensive study of ruins.

THE MECHANICS AND PRINCIPLES OF WALL-BUILDING

There are two basically different types of primitive walls, and these are so familiar that their mere mention gives at once an analytical key:

Mud Walls——————

——————*Stone Walls Laid Up Dry*

The value of mud lies principally in its suitability in plastic form for wall-building[1] and the strength and permanence of the finished monolith made of it. It is needless to point out that a specialized technique was a natural accompaniment to the use of mud to form a monolith. For instance, too wet mud will not stand up,

[1] Mud walls might be subdivided as follows: (*a*) walls of a plastic material, applied like modern concrete or mortar to the monolith under process of construction; (*b*) walls of soft "turtle-backs" or moist masses of mud laid individually in position and pressed or paddled down into place; and (*c*) walls of sun-dried adobe blocks. Exemplifying (*a*) is Casa Grande in the Lower Gila in Arizona, and Casas Grandes in Chihuahua. At these sites, the walls were made of plastic material laid on in stiff wet masses forming courses a foot or two in height (letter from E. B. Sayles to Dr. Martin. This letter corrects the account given by Mindeleff in his Casa Grande report of 1896 where he says that forms were probably used). Each course was allowed to dry before the next was laid on. For the "turtle-back" technique (*b*), see Kidder and Guernsey, 1919, p. 43, for examples near Kayenta in northeastern Arizona. The use of sun-dried adobe bricks (*c*) is mentioned by Mindeleff (1891) frequently, but his review of their use on page 138 implies that they may be traced to the Spaniards. This by no means exhausts constructive comment on mud walls. Alone they offer an interesting and promising field for study.

while mud that is too dry cannot be properly applied, kneaded, and formed to shape. Furthermore, mud walls by primitive people must be built in layers to allow hardening with its consequent strength before the mud is required to support the further weight of additional wall material. In short, a specialized mental training must have accompanied the use of monolithic mud walls, including an understanding of the strength of mud to withstand pressure or crushing (i.e. compressive strength).

When a primitive mason undertook to build a wall of loose stones without the use of mud or mortar, his point of view was radically different from that of the workman who used a plastic material. A pile of separate stones is a mechanically different device from the low mud dam or rim that a savage would shape up to hold water in a spring, and the difference was recognizable even to our primitive wall builder. His first thoughts were of the shapes of the stones with which he worked, and his problem was to place them stably and firmly in the positions necessary to form a wall. Presumably he was occupied by the quarrying and selection of individual stones, breaking them roughly to shape and possibly tooling them, fitting them into his wall, and last but not least firmly wedging them into their final position so that they would not slip out or rock and could not be dislodged too easily. This last operation undoubtedly invited him to use small fragments of rock to fill interstices, to give support at critical points to stones that set unstably in the wall, and to wedge wall stones firmly into their required position. In short, he sooner or later developed a specialized technique whereby he was able to build a stable wall in which each stone, large and small, was firmly held in its place by touching the surrounding stones at a number of points, and the weight of the wall itself was transmitted to the ground by this same stone-to-stone contact. Such a wall is called dry rubblework, a class which still holds an important place in modern masonry.

With a thorough grasp of the difference in point of view of the man who works primarily in a plastic material such as mud and the man who works in stone without mud or mortar, I believe we are equipped to attempt to observe more intelligently some of the techniques using combinations of mud and stone. We can expand the simple key just given by inserting two Intermediate types as follows:

Mud Walls——————

——*Stones Embedded between Cushions of Mud*——————

————*Dry Masonry Technique with Voids Filled with Mud*————

——————*Stone Walls Laid Up Dry*

The dividing line between these two Intermediate types is quite clear and depends on the answer to the question: Is stone-to-stone contact (either directly from wall stone to wall stone or else through intervening spalls that touch both wall stones) a prevalent feature; or is there usually a mud cushion somewhat uniformly separating the upper from the nether stone, unpierced by any jagged projection that would give stone-to-stone contact?

If we find that a true mud cushion is the usual feature, we have reason to believe that the mentality of the mason was not greatly removed from that of the builder of mud walls. Such a wall of stone and mud has only the load-carrying ability of the mud cushions that support the stones. Therefore, the mason had to handle his mud mortar competently if he were to succeed in building a good wall. Undoubtedly he soon discovered that mud was capable of carrying the heavy weight of a massive wall provided that he took the precaution of distributing the weight uniformly over a considerable area of mud. His understanding of the situation was probably similar to that of the Eskimo regarding the use of the snowshoe, which is a parallel case of spreading a load over a large area in order to keep down the pressure on each square inch of area, and thus allow a soft material to support a heavy load.

If a mud cushion is used between the stones, it is necessary to keep the mud mortar very stiff so that most of it will not be pressed out of the joint or else to form some sort of a dam or stop in the joint at the wall face for the purpose of sealing in the bulk of the wet mud. The latter course has often seemed the more desirable, and there is more than one way of accomplishing it. European masons sometimes use two kinds of mortar simultaneously, a stiff mortar placed as a ribbon in the joint close to the wall face to form a stop, and a wetter mortar applied in the center to form the cushion that carries the bulk of the load. In pre-Columbian America, one school of masons—those belonging to the Chacoan culture—solved this problem otherwise by building into the horizontal joints near the surface a continuous dam or stop consisting of small flakes of stone laid in mud. At Aztec, we find this dam or stop made of stone flakes with so little mud that there is practically a stone-to-stone contact supporting the load at the wall face, but as this practice is otherwise closely associated with flakes laid in mud for this purpose, and also because the center of the wall is supported by mud cushioning, we unhesitatingly say that we believe that the mason here thought in terms of mud cushioning rather than along the lines of the methods used in dry masonry.

According to our observations, there was a strong tendency toward the association of mud cushions with slab-like wall stones taken from well-laminated beds of stone. Such stones usually have flat and smooth horizontal surfaces which make them especially suitable to lay on a mud cushion. At Lowry ruin, and at some other places as well, the builders who used mud cushions selected such flat wall stones. At the same sites, other builders who depended on stone-to-stone contact for the strength of their walls selected thicker and more block-like stones from less laminated deposits. As the same rock ledges and quarries of the neighborhood were available to both types of mason, we have considerable groundwork for picturing the mental slant of the artisans who laid their stone in thick beds of mud. The following points stand out:

(1) Like the builders of pure mud walls, they knew that the strength and permanence of their walls depended primarily upon the adequacy of the mud joints. To them, mud was a mortar and not merely a filler.

(2) They knew the necessity of spreading the weights snowshoe-like over a comparatively large area of mud, and consequently showed a marked preference for stones with flat, horizontal surfaces.

(3) Rather than modify the idea of the thick mud cushion, they used a special device to prevent the soft mud from exuding at the wall face. At Lowry ruin, this was a miniature dam in the wall joint composed of small flakes of stone laid in mud. Variations of this device appear elsewhere.

It is hardly necessary to go into great detail to explain the second Intermediate type, namely, "Dry Masonry Technique with Voids Filled with Mud." Where there is enough stone-to-stone contact to allow a good share of the wall to stand if all the mud were washed out of it, we have found it to be a constructive working hypothesis to assume that the mason understood the theory and practice of using stone-to-stone contact, and that this understanding was a basic influence upon his technique. It does not follow that the mud had no other value than that of a filler. After drying out, it acted as a supporting cushion in case the weight of the wall crushed the contacting points of the wall stones. Undoubtedly it also acted as a weak cement, and frequently served to bear up part of the weight of a stone that was not fully wedged into place by spalls. However, in spite of the importance of these other values, we were surprised in our experience at Lowry ruin to find that this hypothesis proved so workable as an aid to analyzing any particular wall.

At this point it is wise to review the use of spalls. At Lowry ruin, these fragments of stone were put to three distinct uses, as follows:

(1) In the Intermediate type of masonry just discussed, the mason was accustomed to select a waste fragment of the correct thickness to prop a wall stone to its proper position when the irregularities of the nether stone could not be utilized for this purpose. In other words, the spall bore the load, and in this case we have consequently named it a "true-bearing" spall. Such spalls are a necessity in rubble masonry when laid up dry, and almost equally essential when laid up in a weak mortar such as mud.

(2) In this same type of masonry we observed that it was usual practice to smooth the walls by applying mud to the joints appearing in the wall face after the wall was laid. If the joint was at all thick, a wedge of stone was pressed into this mud appliqué and we have designated this a "false" spall. Its insertion pressed the mud firmly against the surrounding stones; it also replaced part of the shrinkable mud with stone of unchanging volume, thus diminishing the total shrinkage. It is difficult to say which was its primary purpose, but I suspect the former. It is just possible that such spalls had some ornamental or traditional value. In any case they contributed practically nothing to the strength of the wall, and this is implied by the term "false" spall. This practice of applying mud and false spalls to the outside of the wall adds little if any strength, and I believe should be thought of as a superficial variation, and not as a requirement for the general type.

(3) The third class of spall is called a "stop" spall. It has been described in the previous classification of "Stones Embedded between Cushions of Mud," and it needs no further discussion.

So far in our experience, the first two classes of spalls have been confined to the class of masonry depending upon stone-to-stone contact, and the third has been exclusively associated with stones embedded in mud. I am inclined to think that this association is likely to prevail in some degree wherever masonry composed of stones and mud and spalls may be found; but, regardless of the correctness of this speculation, I feel sure that data on mud, stone, and spalls over the entire field will yield very constructive results.

Most of the facts and logic marshalled so far have seemed to indicate that a careful analysis of any particular mud masonry wall should show that it lies clearly on one side or the other of the division line drawn between mud and stone. This has proved true in a sur-

prisingly large number of cases, but can hardly be general, particularly in the American Southwest, where we have these two technical attitudes of wall-building side by side within a limited area. We must therefore complete our key as follows:

Mud Walls————
——*Stones Embedded between Cushions of Mud*————————
————*Indeterminate Combination of Stone and Mud*——————
——*Dry Masonry Technique with Voids Filled with Mud*————
————————*Stone Walls Laid Up Dry*

This middle class is a necessary addition to take care of blends that cannot be explained, and debatable borderline cases where we only suspect the tendency. We do not yet know how wide or how narrow it would become if our method of analysis were to be used over the entire Southwest, but judging from Lowry ruin it might be comparatively narrow. Where masonry analysis alone fails to show the causes and tendencies of a puzzling blend, possibly its antecedents may be solved by other methods such as age, stratification, sherd association, etc.; and the blend may be correctly fitted into its proper place in the general masonry picture of the Southwest.

SUMMARY

We have sought to extend the possibilities of classifying masonry by means of seeking out certain mental tendencies of the mason, and a simple restatement of our aim and the progress of our work is in order.

A. Our aim is to find a workable classification of masonries that will enable us to tie together similar cultures and to study traits.

B. Such classification obviously depends upon the isolation of certain examples as typical, and upon success in working out a usable description of each type.

C. Elaborate descriptions of masonry did not lead us to a satisfactory and usable key. By this method of attack we found a multiplicity of details which was sometimes contradictory and often confusing. When we disregarded the details in order to clarify the picture, we found that we had failed to construct an adequate basis for sound classification.

D. Confronted by this difficulty, we have digressed into a study of the mechanical principles of wall-building, and devised a plan of classification based largely upon the use which we found of these mechanical principles in the four or five different kinds of

masonry confronting us at Lowry ruin. We have been pleased to find that this method of classification proved to be not only workable, but, in most of our cases, easy.

The reader will easily appreciate that the purpose of this chapter is solely to provide a method of classification and description of Southwestern walls in order to extend our data. However, it may be well to explain that I do not suggest that the masons necessarily understood the principles of wall-building that have been mentioned. The "understanding" of primitive peoples of the laws of nature is of secondary importance here. Whether or not the ancient masons had an inkling of cause and effect, the fact remains that their actual performances had to conform to the mechanical considerations here outlined. Wherever essential principles were violated at critical points in the wall, the result was simple and sure: the wall failed to stand. With modern knowledge, we can appreciate and analyze situations where primitive mechanics and architects groped their way; and, what is more to the point in archaeological research, we can, by our use of this understanding, observe many useful details that otherwise we might not notice. In short, by looking at this masonry through the eyes of the modern engineer and physicist, we are able to see more of the factors that acted as important controls over ancient techniques, and thus to study these techniques more intelligently. Intelligent analysis and recording of a pueblo wall are difficult matters and we are indeed thankful for any helps that physical laws can give us to improve our eyesight, and so to cut some of the haze from the picture that we are trying to define. Our experience along these lines at Lowry ruin was gratifying. There were a number of walls that had seemed so difficult and misleading that I classified them wrongly from the photographs, and even when standing before them no member of our party was certain of his judgment. After developing the methods outlined, we again analyzed these walls; not only were the results consistent and satisfactory to ourselves as clearly indicating certain traits, but our notebook records (supplemented by photographs) were so clear that we were able to satisfactorily re-visualize the walls when we came to work up our notes after returning to Chicago. I believe this success was due to:

(1) Ordinary external observations and the usual photographs.

(2) Unlaying the walls enough to examine their interior structure.

(3) Intensive study of the spalls and their uses.

(4) A clear-cut hypothesis regarding masonry technique.

To me, the last was far from the least important of the four tools just listed. It gave a background against which to register our observations and served as a measure in facilitating comparisons. Fortunately, it was simple enough to be carried in one's mind and used without effort, a most essential factor.

Regardless of the truth or falsity of any of our assumptions, we have succeeded in getting records of the several different masonry techniques uncovered at Lowry. What is more, our records show minor variations in these techniques, and with them we can do analytical work in the laboratory as well as in the field. The discipline is certainly applicable for any of the known masonries in the San Juan district, and probably for a much wider field. If this method of attack can be brought to bear on the various techniques of the San Juan district, we shall certainly have a promising amount of material available for laboratory analysis; and the least we can expect is that tendencies in masonry technique and traits and even in general culture may be indicated. Furthermore, we are not without the hope that such a study of masonries may lead to positive historical implications and reconstructions.

In closing this discussion, it should again be emphasized that we do not imply that the masons who built the walls consciously understood the principles that we find embodied in these walls. The point is that certain natural laws acted as a control over their actions whether they realized it or not. If we analyze their walls with a full comprehension of these principles in our minds, we notice details to which we should otherwise be blind. Some of these details may be of no use to us, but some may give us a key to knowledge that we badly need. Possibly the greatest promise lies in the chance that through a broader and keener vision, we may record facts that are purely incidental from a mechanical standpoint, but that may later prove to be very important anthropologically.

Supplementary Notes

An informal account of our use at Lowry ruin of the principles just explained will be profitable, and in this final division of the chapter, a number of phases of the work will be discussed under several headings.

WALL DISSECTION AT LOWRY RUIN

I have already mentioned how puzzling and even deceptive we found the evidence given by the exposed face of a wall. It was not

until we hit upon the idea of "dissecting" a wall that we began to feel any degree of confidence in our judgment. This operation immediately emphasized three things:

(1) That exposed rectangular faces of wall stones should not be taken as an indication that the buried masses of the stones were equally rectangular and block-like.

(2) That it was an important point in wall-building technique whether the mason who built the wall depended upon the carrying value (bearing strength) of the mud mortar, or whether he arranged the stones in direct contact so that the wall would tend to stand, regardless of whether or not it was well mudded.

(3) That the spalls in themselves usually told an interesting story.

As to the first point, we were surprised to find how irregular the inner surfaces of the stones proved to be. Of course the upper and lower faces of the Chaco-like wall stones were plane and level as that is an essential of the type, but the inner vertical faces were irregular, and interfering corners were very crudely broken off. In the non-Chaco type of wall, almost all the inner faces were irregular, and stones that showed any flat and rectangular inner faces were few. The usual contrast between the outward appearance of a wall suggesting rectangular block-like construction throughout, and the irregular interior was truly remarkable. In short, the outer appearance of a standing wall was no index of its interior.

Regarding the second point, a monograph could easily be written. However, at Lowry, we were not thinking so much of monographs as how to describe adequately and record the walls in front of us; and when we found that the stones of a Chaco-like wall were almost invariably supported by a cushion of mud mortar an inch thick more or less, while many of the stones in walls of the Lowry non-Chaco type were found to touch each other, our enthusiasm was based principally upon the fact that we had discovered a tangible and consistent "earmark" that meant something in our notebook records. It seemed to us then, and has seemed since, that the absence or presence of stone-to-stone contact between wall stones occurred far too consistently to be considered of minor incidental nature. The more we worked with this factor, the more helpful it became to us. In closing, I should mention that we worked out a homely formula for judging the strength value that stone-to-stone contact gave to a wall. It consisted in asking ourselves this question: "If a fire hose giving considerable volume of water at low pressure were played against

this wall until much of the mud mortar were washed away, how well would the wall keep its original shape, and in what manner would it fail?" We found that a serious attempt to answer this question gave us not only a tangible comment on the manner in which the wall stones functioned, but also an insight into the technique of the mason who built the wall.

We also obtained important incidental information by so examining a wall. It practically forced us to note whether the mud mortar was applied conscientiously or carelessly. It caused us to observe more closely whether the hearting was of mud or of rubble, and, if the latter, what kind of rubble. Most important of all, it focused our observation on the manner in which the spalls functioned, and this third subject deserves particular comment.

In many respects, the Southwestern mason was constrained to modify his methods to suit the available material, but this probably applies to spalls less than any other masonry detail. Chips of various shapes and sizes were certainly handy to the wall builder and if we find them assembled in the wall in a consistent, peculiar arrangement, we are justified in crediting the mentality of the mason rather than the geological environment for that arrangement. When used as mortar the same may be said of mud to a considerable degree. When we unlaid sections of wall at Lowry, we found that spalls were used in the consistent and peculiar method just suggested, and that the spalls and mud in the joints of the masonry gave promise of helping to tell the story of the people who built the pueblo. The more carefully we studied the matter, the more we were convinced that we here have a factor useful both in classifying the masonry itself and in tying certain styles of masonry together in a common culture. Finally, these conclusions helped us greatly in our immediate problem of writing down intelligible notes.

We did not neglect the outer appearance of the buildings in our enthusiasm for taking them apart; far from it. However, with our eyes opened to look for these three additional features mostly hidden within the walls, we felt that our descriptions were comfortably within the boundary that separates the adequate from the inadequate. We believe that the matter presented in the chapter is on sound ground, and invites analysis beyond our own.

In classifying the wall stones themselves we made an arbitrary division of the mason's work; this division helped us, and it may be worth mentioning here. We distinguished between the function of the quarryman, that of the finisher or hewer of the stones, and that

of the mason who laid up the wall. For instance, we said of the non-Chaco mason that he accepted anything within reason that was handed to him. On the other hand, the Chaco-like mason accepted only stones that conformed closely to a specified character. In other cases we would remark that the quarryman was apparently unable to get out stone that was up to the specifications for the desired style and that it seemed to us that the style of finished wall was accordingly modified. Of course, we have no reason to presume that there was any such division of labor among the pueblo builders, and our artificial assumptions were probably overdrawn. However, there is certainly a division of function within the mason's technique, and this will be realized by the student of masonry.

So far, I have been reviewing the part of our field of study where progress was satisfactory, but I must also discuss a feature which shows the need of caution in drawing conclusions. Emphasis has been laid on the fact that most of the walls studied were (roughly speaking) either of flat stones laid between thick cushions of mud, or of more jagged stones laid so as to touch each other after the manner of "dry wall technique," with a filler of mud in the voids that was incidental from the standpoint of strength. Our classification scheme has suggested (although not stated) that the use of mud cushions might be a cultural attribute persisting in a given school of masons regardless of the character of the available stone. This is not necessarily so. A flat stone from well-laminated beds lends itself to a technique where mud cushions carry the load and transmit it downward from course to course. However, if a stone with jagged lower surface is substituted for a flat slab, the pointed and irregular projections pierce into the layer of mud mortar composing the joint, and they are likely to make occasional stone-to-stone contacts with the stone below. If the wall stones selected are jagged enough, these stone-to-stone contacts will become sufficiently frequent to carry the greater part of the wall load; and, from a cushion carrying this load, the mud joint will consequently change to a mere mud filler of secondary importance to the strength of the wall.

In short, it must be borne in mind that the "mud cushion" of itself is not an independent factor in masonry construction, but is often linked with other factors. However, I can see no necessity of going to the opposite extreme and concluding that it is a mere incident entirely dependent on other factors. It is so noticeable and important a feature in technique, and its presence or absence has so pronounced an effect on the character of the wall, that in my opinion

a school of masons who had once mastered its use and shown a preference for it would have been rather persistent in retaining it, even though change in environment made it less necessary. For instance, it would be possible for such a school of masons to hew their stone with flatter horizontal faces if they wished to maintain their habit of laying wall stones upon a mud support; or, as was more probably the case, they could make special efforts to find quarries that produced stone of a laminated character.

Regarding the use of the mud cushion for carrying loads, I wish to emphasize the fact that in spite of its dependence upon other factors it probably can be handled to a considerable extent as a cultural trait of the sort that often manifests persistence. Such a characteristic as this cannot be used blindly by the archaeologist but requires thoughtful application. When it is so treated, I believe that others will find it helpful, as we did at Lowry.

SURFACE APPEARANCES

We have been emphasizing the anatomy of a wall's interior. Its outer appearance is also important, but there is hardly need for emphasis on study of external appearance, as it has been receiving fairly adequate attention. However, Dr. Martin has used a proportional count of wall stones according to size, as a help, and this has proved a valuable check to classification work. Where the observer wonders if he has correctly classified a difficult wall, it is very reassuring to find as a check that the proportion of large to small stones is consistent with the type specimens. This test is also valuable as a direct aid to classification.

Of course other features are evident on the face of a wall and invite attention. As early an investigator as Victor Mindeleff commented upon the banded effect found in the Chaco masonry and remarked that "its decorative value began to be appreciated, for it is apparent that its elaboration has extended far beyond the requirements of mere utility." (Mindeleff, 1891, pp. 138–145.) Mindeleff also notes the practice among other tribes of applying coats of mud as a plaster over the masonry. This latter custom, and the repair and refinishing of older walls by later masons who used a different technique, were practices that give the modern archaeologist reason to be wary in interpreting appearances. It is unnecessary to review here the various features observable by merely looking at a wall, but most of them bear on our classification problem and will be taken into account by the serious student.

POSITIVE RESULTS OF WALL ANALYSIS

Any student who has read thus far will want to know just how helpful the analysis of masonry proved to us in reconstructing the history of Lowry Pueblo and its occupants. I shall try to indicate this by listing the specific cases or problems concerning which we turned to the masonry technique in search of enlightenment, and by giving a brief description of the results obtained. In following these, the reader should keep Figure 4 in mind. "Masonry technique" does not here refer to the working out of sequences by observation and analysis of the manner in which two walls join. This is a different method of approach and will be referred to as "wall abutment analysis."

(1) The correlation of Room 18 with the Great Kiva is based almost entirely on study of masonry techniques as there are no tree ring dates for either Room 18 or Kiva F, the walls of which interlock at the point of juncture. Nor are there walls connecting this room with the nucleus in such a manner that the wall abutments reveal a probable building sequence. The walls of both Room 18 and Kiva F, and those of the Great Kiva were of the same Chaco-like technique laid up with mud cushions and stop spalls in the typical Chaco-like manner. However, they constituted a special case, characterized by a heavy percentage of block-like, dimpled stones of a non-Chaco character as well as slabs with chipped edges. This peculiar combination can hardly be a coincidence, and it warrants the conclusion that both structural units belong to the same period. As the Great Kiva is dated A.D. 1086 by eight of its wooden beams, we feel that Room 18 and Kiva F take a date very close to this.

It should be noted that we did not find justification for correlating Room 18 and Kiva F with the nucleus. The latter is the type case for the pure Chaco-like technique at Lowry, while the former is an easily distinguishable variation.

(2) The workmanship of the nucleus is exceptional and would do credit to a modern mason except that there is no consistent breaking of joints (Plate XXII). In contrast, are all the other structures shown in the second addition (Plates XXIX–XXXI), inasmuch as their masonry is comparatively rough, and devoid of neatness of workmanship found in the nucleus. Casual inspection suggests that these two kinds of masonry are not closely related, but dissection of the walls tells a different story and shows conclusively that they all have in common the Chaco-like mud cushions between the stones, and stop spalls that were laid into the joints

as each course was erected. These highly specialized characteristics place them all in the same class in spite of outward appearances. It is interesting to find this confirmed by the closeness of the tree ring dates of the Great Kiva (A.D. 1086) to those of the nucleus (A.D. 1090).

(3) The square about Kiva B was very puzzling. The masonry technique appeared entirely Chaco-like (Plates XXV–XXVI). The coursing is very noticeable, and, on the whole, the stones are consistently thin and slab-like. Few are dimpled. In the summer of 1934 we did not know whether to put this earlier or later than Room 18, but our problem was solved in the autumn when we received the report that the tree ring data from Room 27 definitely dated that structure A.D. 1104. This part of the ruin was a problem that the study of masonry technique failed to solve, although I believe it helped to clear away some of the fog.

Digressing for a moment from this numbered list, I will say that the receipt of the dendrochronological results gave such satisfactory data on the correlation of the Great Kiva, the nucleus, and the square about Kiva B that the need for intensive exploitation of the masonry traits for that purpose almost vanished. With these key points and Room 18 correlated, the remainder of the problem of room sequence was comparatively simple.

(4) The walls of Rooms 11, 12, and 14 abut the east side of the nucleus and therefore obviously follow it. However, it was first from comparative masonry technique that we also decided that these three rooms were built later than the original square about Kiva B. The walls are of blocks rather than slabs and it was obvious that they usually make stone-to-stone contact (Plate XXIX). Chaco-like stop spalls are absent and in their place are some true-bearing spalls and many false spalls. I believe it unlikely that these non-Chaco walls were built during the same occupation of the pueblo as the structures shown in the first addition (Fig. 53, *b*). Even if I am mistaken, the marked change in masonry traits shows that considerable disturbances of the culture of these builders occurred at this time. Subsequently, by means of a very intricate analysis of the several wall abutments joining Kiva B to the nucleus, Dr. Martin confirmed the theory that these rooms followed the square about Kiva B ("x" area).

(5) Wall abutment evidence clearly shows that Rooms 4, 5, 6, and 20 followed the nucleus. They are non-Chaco in masonry technique and similar to Rooms 11, 12, and 14, so it is natural to

assign them to approximately the same period (Fig. 53, *c*). Of course the wall abutments and the outlying position of both these groups suggested that they were later additions long before we applied to them the test of masonry technique. There is a scant sprinkling of Chaco-like stop spalls in some of the walls of Rooms 4, 5, 6, and 20 which suggests that these rooms were not quite contemporaneous with Rooms 11, 12, and 14, where few were observed. However, this is only a suggestion, not a conclusion.

(6) Kiva D has inter-pilaster shelves exactly like Kiva B, and the masonry technique of the two kivas is almost identical. We therefore assign both kivas to the same period.

(7) Study of the wall abutments of Rooms 16, 22, 23, 24, and 25 shows continuous interlocking with each other and with Kiva D. Consequently, we consider the entire group of the same period to which we have just assigned Kiva B and Kiva D. I found in Room 16 many Chaco-like characteristics although in general appearance it is not entirely Chaco-like. I am therefore inclined to assign this room and those adjoining to a time rather close to that of the first addition (Fig. 53, *b*). This conclusion is emphasized by the fact that Kiva B and Kiva D themselves are both built of masonry that is close to the definition of Chaco-like.

(8) In short, a study of the masonry techniques tends to place the groups just discussed in the following order: first, Cases 6 and 7 (just given); and later, Cases 5 and 4. As Case 5 shows some trace of Chaco technique while Case 4 shows none, there is a suggestion that Case 4 followed Case 5.

These eight cases give a fair picture of the value of intensive masonry analysis at Lowry. It gave us definite help in some cases. In others, it was sometimes constructively suggestive and sometimes confirmatory of other methods of investigation. In some cases it was disappointing. I feel sure that it would have been of more help to us if we had possessed a background of data from other sites, but on the whole we have reason to be thankful for the help that it gave.

Aside from the use of these intensive analyses as an aid to historical reconstruction, it seems to me that the studies of the traits themselves give more than an inkling of the mentality of the peoples who practiced them. In every examination that I made of masonry in the San Juan district, the personality of the individual mason who laid the stone appeared to be reflected to some degree in the present standing wall. Dr. Martin has interpreted the cultural

background of Lowry Pueblo as one of change and possibly turmoil. This is the exact situation that was pictured by the masonry study alone, just as soon as the tree ring evidence made it clear that so much of the architectural history of the complex was compressed within so short a space of time.

There is one point that I cannot omit, although the evidence is limited. In Case 1 we mentioned that there were incorporated in the Chaco-like technique of the Great Kiva, Room 18, and Kiva F some block-like wall stones dimpled with a pecking stone and displaying technique unlike the typical Chaco-like examples. These dimpled stones were probably re-used, and this supposition was borne out by our finding in the wall, half of such a stone with the fractured end placed outward and serving as part of the wall face. Dimpled sides of this stone were buried in the wall but the exposed end was not dimpled, so there is no question as to the re-use of this particular stone. From the presence of many such dimpled block-like stones used secondarily in our earliest Chaco-like walls (dated A.D. 1086) there is an obvious deduction; namely, that a pueblo of some size and presumably of non-Chaco nature preceded the pueblo pictured in Figure 53, *a*, and was completely razed before or during the erection of the latter pueblo, whose ruins we know.

POSSIBLE SOURCES OF MASONRY TRAITS

This chapter has touched upon three phases of masonry, namely:

A. Methods of classifying and describing it.

B. Its application to the architectural history of Lowry ruin.

C. The suggestion that the study of masonry traits may prove fruitful in itself due to their ability to reflect cultural permanence or change.

There is a possibility that masonry may reflect a fourth phase (D) which will take much more than a line to describe, and which I shall now outline.

In presenting phase A, I explained that the grouping was for classification purposes only, and implied neither cultural nor historical significance. Its value was based solely on workability. The applications in phase B were confined to the immediate and tangible problems of Lowry ruin. However, in working out these phases, I was struck by the way in which they pointed to a rational explanation, and I present this now as a hypothesis, although I am aware of the need for caution in rationalizing human development.

Throughout this study two opposing traits of wall-building stand out: (1) *Mud Cushioning*, or the use of mud as a mortar supporting the stones and the wall above it. Where this trait is pronounced, the wall is no stronger than a wall built almost entirely of mud. (2) *Stone-to-Stone Contact*, or dependence upon wall stones or spalls to carry the load of the wall above each stone. This trait is best exemplified in a dry wall. Where this technique prevails, mud or other mortar, if used at all, is primarily a filler.

For anyone who has seen occasional stones or even gravel incorporated in a mud wall, it is very easy to assume that the trait of mud cushioning goes lineally back to an all-mud wall. With this in mind, it takes no stretch of the imagination to complete the hypothesis by ascribing masonry walls showing stone-to-stone contact to a continuous tradition originating in dry walls laid up without mortar of any sort. This suggestion that these two styles of wall-building were fairly continuous, independent traits is the fourth phase D and it seems to come spontaneously out of this masonry study. If enough data should be found to confirm it, we shall be able to analyze a wall, link it with certain cultures, and use the results in historical reconstruction. In any case we can use even present results for a pointer as to which direction it will pay to look in search of more data.

It is not difficult to find evidence supporting the first part of this hypothesis. There are enough remains of early adobe or *caliche* construction in the Southwest to allow us to presuppose that it was the building medium of some of the important pueblo peoples; e.g. Casa Grande and other Lower Gila sites, and Casas Grandes in Chihuahua (Kidder, 1924, pp. 106, 113, and 115), and the adobe remains spread over Utah (Kidder, 1924, p. 80). That people using mud as building material did not hesitate to combine it with wood is shown by the remains of stake walls covered with mud at Casa Grande (Fewkes, 1912, plate 26), and other cases where adobe has been reinforced with sticks or brush. This takes us a move beyond our basic mud stem.

Mr. Harold S. Gladwin has kindly given us photographs of his recent excavations at Red Mesa near Gallup, New Mexico, and a story of masonry evolution is told in the descriptions alone of the photographs. Space does not permit us to reproduce the photographs; therefore I list the descriptions in chronological order:

(1) View of a mud wall containing a few medium-sized stones or boulders well scattered.

(2) View of similar wall in the same structure reinforced with brush-and-pole framework (the photograph has the notation "wind-break extension similar to those in Gila Basin.").

(3) View of a mud wall with a course of large untooled boulders supplemented by a few stone slabs at a moderate height above the base of the wall.

(4) View of mud walls with a course or two of thin sandstone slabs inserted at a moderate height above the base of the wall (House 1).

(5) View of a mud wall with six or more rows of thin sandstone slabs laid in courses and beginning at the same height as before. A mud cushion almost as thick as the slabs appears clearly between the courses (House 2).

(6) View of slab masonry wall laid above a mud wall. The masonry is entirely of stone slabs carelessly laid in mud and poorly coursed. However, a fairly straight face as a whole is maintained in the wall.

No scale is shown on the photographs but I judge that in each case the course or courses of stone begin about two feet above floor level. The first two houses are dated A.D. 850 plus(?); the next two, A.D. 850–900; the fifth, A.D. 900 plus(?); and the last, A.D. 950. I infer that these are tree ring dates, and it is evident that Mr. Gladwin has formed an opinion regarding the time sequence of these walls. (His report on Red Mesa is in preparation.) Here is evident a series of steps that almost connects our mud stem with the Chaco-like technique of Lowry ruin and the more classic examples at Aztec and at Chaco Canyon. After Red Mesa, it only required refinement in the coursing and the invention of stop spalls to produce the finest masonry of the Southwest. Dr. Martin first called my attention to Mr. Gladwin's photographs and their relation to our Chaco-like masonry. He writes me further that "these Red Mesa houses were probably built by the ancestors or forerunners of the people who built the Chacoan part of Lowry, for it is from this region (near Gallup, New Mexico) that we believe that the Chacoan culture spread north to Lowry and east to Chaco Canyon."

We now turn to a search for data that may help us to reconstruct the probable history of the use of stone in pre-Columbian architecture either without mud mortar or with mud playing the secondary role of a mere filler. I have found almost no evidence connecting stones laid absolutely dry with our earlier peoples, but this is to be expected. Such remains must have proved convenient

quarries for succeeding generations; also, such earlier architectural efforts were probably at or below ground level where the interstices would be naturally filled in, regardless of the builders' plans. Many of the Basket Maker cists and pit-houses probably fall in this last group and the megalithic enclosures of stone slabs set on edge at McElmo Bluff in southwestern Colorado (Fewkes, 1919, p. 61) seem to show that their architects thought primarily in terms of stone rather than mud. If we leave the Southwest, we can turn to Fowke's illustrations of graves and vaults in Missouri for walls of stone built without mud mortar or with mud as a very minor contribution (Fowke, 1910).

The slab-lined pit-houses alone are conclusive evidence that the careful grouping of individual stones was a widely spread cultural trait in this horizon.

Turning from this evidence of an early technique in the use of stones as individual basic wall units, we will investigate later examples. I find that few archaeologists have recorded reliable observations of dry laid stone-work, but there are some published data. Kidder and Guernsey (1919, pp. 26, 33, 53, and plate 6*c*) record a small watch tower, four rooms of a cliff dwelling, and a small granary peculiarly constructed, all in the Monuments district of northeastern Arizona, and in each case the absence of mud-mortar is noted. At Mesa Verde, in the upper gallery of Cliff Palace, up against the cave roof, is a section of dry masonry wall (letter from Mr. Robert Burgh), and possibly the turkey pens at the back of the cave may be mentioned, although they are only random rocks piled to form the crudest sort of wall. I must finally mention the frequent and extensive use of rock, laid with stone-to-stone contacts to form reservoir walls. Some of these are crude, but others are true masonry, as for instance one shown by Kidder and Guernsey (1919, plate 23*a*). Of course they were backed up by a seal of mud, but that does not affect the masonry technique. If such reservoirs were used in Basket Maker times, we have here a continuous practice of stone-to-stone contact as a dominant feature.

Discussing these data regarding dry walls and those built with "dry wall technique," it appears that some American tribes took their first step in the use of non-perishable materials for walls by assembling individual stones regardless of the use of mud or mortar. That this appears in definite territories, such as the Mississippi Valley and the Southwest, and that stone-building of any sort is practically unknown in others, such as the Pacific Coast and the

Atlantic watershed from eastern Canada to the Carolinas, confirms the idea that it is a cultural trait rather than an occasional accident (Holmes, 1919, pp. 99 and 116). Later this practice cropped out from time to time in the Southwest during its pre-Columbian history. Whether it was invented each time it was used or whether it was a trait governed by precedent is at present a matter of speculation, but I think that the evidence justifies me in outlining the latter possibility at least for further study. Of course, the gaps and lack of any series of progressive cases (as we found in mud-cushioning technique) are discouraging, but we must not forget that all these American peoples had a continuous tradition in the use of stone for artifacts, and it appears to me that there was probably a more or less continuous background of the art of selecting, shaping, and assembling individual stones regardless of the mud filler. This might have existed as a homely and unhonored art much of the time, but still have been continuous. Not the least argument along this line is a *reductio ad absurdum*. I cannot believe that every masonry wall of this class in the Southwest and neighboring territory was either a spontaneous invention or else could trace direct descent back to some early wall of pure mud. It is easier to think that the practice of placing stone on stone for some simple purposes was a fairly continuous trait, mostly used in informal structures and cropping out more conspicuously from time to time.

With two basically different masonry traits existing simultaneously and more or less in the same general territory, there would almost surely be diffusion between the two. This is particularly so as stone and mud are the common materials used in all but the pure stem types, and it would be furthered by the tendency of flat stone-work to encourage the use of mud cushions, and jagged stone-work to force stone-to-stone contact. However, just now there is greater need for more data to work with than for amplified discussion of this situation.

The weak point in this hypothesis is the scanty evidence on the continuity of stone-to-stone contact masonry. Nevertheless, the scattered data presented certainly offer a clew worth following up; and if there is any reasonable amount of evidence supporting this part of the hypothesis, there is hope that we may have a new gauge that will be useful in correlating history with masonry. In any case, I shall be satisfied if this discussion provokes (the verb is used advisedly) enough interest to insure enlargement of our present limited data on the details of masonry.

VII. THE SKELETAL MATERIAL FROM THE LOWRY AREA

BY

Gerhardt von Bonin, M.D.

Introduction

This chapter was written in the Department of Anatomy of the University of Illinois. The figures and photographs were made in the Illustrating Department of the College of Medicine of the University of Illinois and were later re-photographed and converted into photogravures at Field Museum of Natural History. The writer wishes to thank Dr. Otto F. Kampmeier for putting the resources of the Department of Anatomy at his disposal, and Miss Marion Mason and Mr. Lawrence A. Toriello for executing the drawings of the text figures.

This Report deals with the human remains found in the Lowry ruin as well as with some material which was found in the vicinity. The former belong to Field Museum of Natural History; the latter, to the Department of Anatomy of the University of Illinois. These were dug from mounds by the writer during the summer of 1930 when he was a guest of the Field Museum Expedition. Dr. Martin reports that altogether thirty-four burials were found, but most of these were incomplete or in a very bad state of preservation. Measurements were taken only on parts of thirteen skeletons.

The material described herein as "Lowry" came from refuse mounds of that ruin; and the material referred to as "Ackmen," came from refuse mounds located within a mile of Lowry ruin.

Twenty-four burials were flexed and ten, extended. Of the flexed burials, eight faced west; four, east; eight, south; and four, north. Some of the skeletons were barely a foot underground; others were three feet below the surface.

Two problems present themselves immediately in connection with such material. In the first place, the racial relationships of the people represented by this sample require elucidation. But beyond that, it may be possible to answer questions of a more general nature pertaining, e.g., to artificial deformation of the skull, to the relation of cranial capacity to stature, etc. It is clear that the small number of individuals seriously detracts from the value of any answer to these questions. The errors of random sampling will be large, and interpretation of the results will not go beyond a judgment of probability which we may have to revise when further material will have come to light.

We give a list of the skeletons here dealt with:

TABLE 1.—TABULATION OF BONES MEASURED

	Skull	Humerus	Radius	Ulna	Femur	Tibia
MALES						
Lowry ruin						
47575	+	+	+	+	+	+
47615	+	+	+	+	+	+
47619	+	+	+	+	—	—
Ackmen						
7	—	—	+	+	+	+
21	+	—	—	+	+	+
22	+	—	+	+	—	—
27	+	—	—	—	+	—
Total	6	3	5	6	5	4
FEMALES						
Lowry ruin						
47614	+	+	+	+	+	+
47616	+	+	+	+	+	+
47617	+	+	—	—	+	+
47618	+	+	—	—	+	+
47620	+	+	—	+	—	—
Ackmen						
11	—	+	—	—	—	+
14	—	+	+	+	—	—
16	—	—	—	+	—	—
23	+	+	+	+	+	+
26	+	+	+	+	+	+
29	—	—	—	—	+	+
Total	7	9	5	7	7	8
Ackmen (doubtful)						
9	—	—	—	—	+	+

The craniometric and osteometric methods used in this Report require but few words of comment. In craniometry the author has followed the technique employed in the Biometric Laboratory by Karl Pearson and his collaborators. A short description of it has recently been given by Morant (1930). Most of the measurements are the same as those defined by R. Martin in his well-known "Lehrbuch" (1928). Table A gives once more a synopsis of these definitions. For the femur the writer has followed the definitions of Pearson and Bell (1919) given in their monograph. For the other long bones Martin's technique has been used. It will be seen that far more measurements have here been taken than is generally the custom. None the less, this Report lays itself open to being accused of omitting almost all determinations of angles. In the first place, the experience of Pearson and Bell on the femur showed that the variation of most angles was too large to be useful for racial comparison. Secondly, most angles are poorly defined; consequently, it is almost impossible to be sure that the measurements taken here would be comparable to those of other authors.

It is not enough nowadays to throw page after page of figures at the reader and leave him to his own devices. He has a right to be told what these figures mean and what can be deduced from them. True, in many cases figures are no more than a record to be added to the accumulating stock of our knowledge, useful only in the future when this stock will have grown to more respectable size. Yet it is well to analyze at each step the facts already known, thus to find out what kind of information is most urgently needed and to check the conclusions of other authors.

The statistical tools needed for this are by no means numerous. Practically all characters with which the physical anthropologist has to deal are distributed according to the "normal" curve of errors of Laplace and Gauss, and this curve is mathematically completely defined by its mean and its "standard deviation." The first constant gives its position, the second measures the amount of scattering around the mean which the individual values of the series show. (The reader who desires to go deeper into this matter should consult any of the numerous textbooks on statistics. R. Pearl's [1927] and R. A. Fisher's [1928] are those used most frequently by the writer.) If the standard deviation is known, the probability with which in that series a given individual value is to be expected can be determined, preferably by means of any of the numerous tables available for this purpose. Supposing several samples of size n be drawn from the same population, then the means of these samples will have a standard deviation e equal to:

$$e=\sigma/\sqrt{n} \qquad (1)$$

This quantity is generally known as the standard error. To determine whether two series come from the same population or not by comparing their means, the standard error of these means has to be taken into account. In that work, use is made of the formula for the standard error of the difference. Let $x_1 \pm e_1$ and $x_2 \pm e_2$ be two means with their standard errors. Then we have:

$$x_1 - x_2 = \Delta \text{ and } e_\Delta = \sqrt{e^2_1 + e^2_2} \qquad (2)$$

Let now x_1 and x_2 be the means, e_1 and e_2 their standard error, n_1 and n_2 the number of individuals of each series and σ the standard deviation, supposed to be the same for both series (numerous experiences have shown this to be a legitimate assumption). Remembering the formulas (1) and (2), we can define a quantity t by:

$$t=\frac{\Delta}{e_\Delta}=\frac{\Delta}{\sigma}\sqrt{\frac{n_1 n_2}{n_1+n_2}} \qquad (3)$$

the square of which will be called

$$\alpha=\left(\frac{\Delta}{\sigma}\right)^2\frac{n_1n_2}{n_1+n_2} \tag{4}$$

For small values of n_1 and n_2, t is not normally distributed but the probability for any value of t has been tabulated by R. A. Fisher (1928, Table IV). It is to be remembered that in his table n equals n_1+n_2-2 since each series has one degree of freedom less than n_1 or n_2 respectively.

For a general measurement of divergence between two series it has become customary to compute the value of the function α for a number M of measurements and to take its mean value. Karl Pearson (1926 and 1928) has shown that this value will have a mean of 1, if the two series come from the same population, and he has defined as coefficient of racial likeness:

$$\text{CRL}=\frac{\Sigma\alpha}{M}-1 \tag{5}$$

It is not safe to apply this method to series of less than ten individuals (the various α's [just as $\sqrt{\alpha}=t$] are not normally distributed. Moreover, series of less than ten will be apt to represent only one or two families and so show family rather than racial traits), but it provides one of the most useful tools for statistical analysis if longer series are available. From a theoretical standpoint the method has recently been discussed by Pearl and Miner (1935).

Before proceeding further we shall first have to satisfy ourselves that the two collections with which we are dealing can be considered as samples from the same population. This is, of course, *a priori* very likely since they have been found within an area of a square mile, associated, moreover, with the same type of cultural implements. None the less, it would be more satisfactory if a numerical estimate could be provided. In order to arrive at such figures we put together some measurements of the skull and of the femur. Unfortunately, occipital flattening, present in almost all skulls, has played havoc with the shape of the brain case so that for purposes of comparison only the face can be used. Of the skull we take, therefore, the least frontal breadth B′, the length of the base LB, the upper facial height G′H, the nasion angle N∠, and the nasal and orbital indices. Of the femur, the maximum length, the indices of the proximal, middle, and distal cross sections of the shaft, the index of robusticity and that of the neck were selected. In estimating the difference between two means, known values of the standard deviation were used since they were thought to provide better estimates than those which could be

TABLE 2.—COMPARISON OF SOME MEASUREMENTS OF LOWRY RUIN AND ACKMEN SERIES

	Lowry ruin	Ackmen	σ	t	P	Lowry ruin	Ackmen	σ	t	P
Skull		*Males*					*Females*			
B′	97.6(2)	93.4(3)	4.05	1.12	0.35	88.7(3)	89.7(2)	3.79	0.28	0.80
LB	106.5(2)	98.2(2)	3.97	1.29	0.30	94.7(1)	101.4(1)	3.52	.....	....
G′H	73.0(2)	68.7(3)	4.15	1.12	0.35	65.2(1)	69.8(2)	3.76	0.996	0.50
N∠	58°.0(2)	65°.8(2)	3.31	1.54	0.25	64°.6(1)	76°.5(1)	3.26	.....	....
100 NB/NH	49.8(2)	54.4(3)	3.82	1.20	0.30	49.1(1)	49.2(2)	3.77	0.02	0.90
100 O_2/O_1L	72.5(2)	82.1(3)	5.05	1.51	0.25	86.4(2)	85.6(2)	4.59	0.17	0.90
Femur		*Right Females*					*Left Females*			
Max. length	414.2(3)	398.7(3)	20.11	0.944	0.40	428.2(2)	396.7(3)	21.05	1.64	0.20
Platymeric index	73.6(4)	73.1(4)	9.61	0.09	0.90	75.6(4)	74.4(4)	8.19	0.21	0.80
Pilastric index	109.0(4)	116.6(3)	9.17	1.09	0.30	111.6(4)	114.6(4)	9.42	0.45	0.60
Index of robusticity	12.1(3)	12.4(3)	0.855	0.430	0.65	11.9(2)	11.9(3)	0.826	0.00	1.00
Popl. index	75.4(3)	84.7(3)	5.67	2.01	0.12	77.2(3)	83.8(4)	5.73	1.51	0.18
100 n_v/n_h	81.1(3)	74.4(3)	5.85	1.40	0.22	77.9(3)	77.2(3)	5.20	0.17	0.80

derived from samples as small as those with which we are dealing here. For the skull, the values of the long Egyptian "E" series of Pearson and Davin (1924) were used, for the femur those from the English femora of Pearson and Bell (1919). From the function t, the probabilities that the two samples belong to the same population were found by means of R. A. Fisher's table (1928, Table IV). In no case is there any reason for suspicion, since the probabilities throughout are higher than 0.1. Yet a few interesting points emerge. The fact that the male skulls show a somewhat greater divergence than the females may not be worth stressing since it is a well-known rule that differences in the value of P, say between 0.9 and 0.3, should not be taken too seriously. None the less it might be worth noticing that the nasion angle both in males and females is considerably smaller in the Lowry ruin skulls than it is in the surrounding Ackmen population. Very likely we are confronted here with a family peculiarity. No such clear-cut family traits can be found in the femur, except perhaps the greater length in both males and females from the Lowry ruin.

None of these differences, however, are significant in a statistical sense and we shall treat both series as coming from the same population and shall compare their pooled means with those of other populations. This pooled series will subsequently be called Lowry.

The present Report is confined to the long bones and the crania, since only these appear to afford sufficient interest to warrant their detailed description. In spite of the fairly large amount of material from America (and elsewhere, for that matter) which is available in the literature, we still miss an attempt at its analysis according to modern biometric methods. Consequently, we are almost completely ignorant of the significance of the facts which have been brought together. It will, therefore, be our first object to analyze the available data, at least so far as to enable us to arrive at broad outlines of an osteology of the American Indians. When that has been done, we shall be able to judge how much we can learn from our own material about its racial affinities. The same principle will be applied to the craniological chapter.

THE LONG BONES
(Plates LXXXV–LXXXVIII)

We shall begin our discussion of the long bones with a consideration of their lengths, highly correlated with stature as well as with each other. Table 3 gives a synopsis of the material we have been

able to gather from the literature, including only those means which are based on ten or more individual measurements. Most series come from the territory of the United States, the Salish (Dorsey, 1897) from the northwest, the Munsee (Hrdlicka, 1916) from Delaware in the east, the Arkansas and Louisiana (Hrdlicka, 1909) from districts near each other in the south, and the Pecos Pueblo (Hooton, 1930) and the Lowry from the southwest. Only the Paltacalo series (Anthony and Rivet, 1908) from Ecuador and the Peruvian series (McCurdy, 1923) are from South America. While the measurements on the ulna, radius, and femur have, as far as can be ascertained, been taken in the same way by all observers, some doubts arise about those of the tibia. Both McCurdy and Hooton have, it can be assumed, followed Hrdlicka, who has measured the Munsee, Arkansas, and Louisiana. In his "Anthropometry" (1920) Hrdlicka describes an osteometric board with a hole in the transverse wall for reception of the spine in measuring this bone. This measurement is not included in R. Martin's technique, but his "Ganze Länge," No. 1, must come close to it. It is fairly certain, on the other hand, that Dorsey's Salish as well as Rivet's and Anthony's Paltacalo have been measured by different definitions. In view of this situation it is perhaps safer to confine a survey of bodily proportions to the radio-humeral and humero-femoral indices. These figures, in all cases the indices of the means, are included in Table 3A. For the computation of these indices the maximum length of both humerus and radius and the oblique length of the femur have been used as the only values available throughout. These indices are, therefore, not comparable to those defined by other authors.

The means alone hardly convey an accurate impression of the differences found between these series. In order to judge whether these differences are statistically significant or not, the function α between all the groups will have to be computed. A difference may be considered significant when α is greater than ten; when, in other words, as a short consideration will show, the difference between the means is greater than three times its standard error (cf. formula 4 above). This has been worked out for one absolute measurement, the oblique length of the femur, and one index, the radio-humeral. Table 3B gives the numbers. In the first case, the standard deviation given by Hooton for the Pecos Pueblo series, 19.95, has been used; in the second instance, for want of a closer race, that given by Warren (1897) for the Egyptian series from Naqada, 2.145. The absolute dimensions show much greater differences than the proportions of the

Table 3A.—Length of Long Bones (Right), American Indians

	Pecos	Munsee	Arkansas	Louisiana	Salish	Paltacalo[1]	Peru
Males							
H	310.2(128)	325.0(14)	327 (9)	327.0(19)	315.4(10)	293.8(32)	291.8(25)
R	239.6(91)	256.5(11)	250 (3)	253.0(10)	240.0(10)	227.1(14)	221.8(18)
F	427.2(142)	....	....	....	423.8(10)	412.7(61)	397.8(44)
F′ (obl. length)	423.9(145)	452.6(14)	456 (14)	441.0(19)	420.7(10)	408.2(56)	394.1(44)
T	....	....	....	....	344.3(9)	....	....
T′ (less spine)	357.7(130)	385.0(12)	385 (7)	371.0(13)	334.4(9)	343.7(42)	322.6(30)
100 R/H	77.2(91)	78.9(11)	76.5(3)	77.4(10)	76.1(10)	77.3(14)	76.0(18)
100 H/F′	73.2(128)	71.8(11)		74.1(19)	75.0(10)	72.0(32)	74.0(25)
Females							
H	288.9(96)	307.0(15)	....	302.0(13)	....	272.1(29)	269.2(13)
R	219.4(68)	236.6(11)	....	227.0(14)	....	208.0(5)	202.5(8)
F	394.3(102)	....	....	....	....	377.1(42)	372.7(35)
F′ (obl. length)	392.0(106)	421.0(13)	....	412.5(12)	....	371.9(38)	367.9(35)
T	....	....	....	....	....	....	....
T′ (less spine)	327.2(90)	353.0(13)	....	348.0(10)	....	311.3(31)	302.9(12)
100 R/H	75.9(68)	77.1(11)	....	75.2(13)	....	....	....
100 H/F′	73.7(96)	72.9(13)	....	73.2(12)	....	73.2(29)	73.2(13)

[1] Both sides.

Table 3B.—Value of Function *a* for Male Groups Given in Table 3A

Upper right: for oblique length of femur. Lower left: for index R/H

	Pecos	Munsee	Arkansas	Louisiana	Salish	Paltacalo	Peru
Pecos	....	26.44	33.05	12.33	0.11	25.01	75.35
Munsee	6.17	.....	0.20	2.72	14.91	55.50	91.31
Arkansas	0.31	2.95	.....	4.56	18.25	64.30	71.90
Louisiana	0.08	2.56	0.41	.....	6.79	38.35	73.34
Salish	2.37	8.92	0.08	1.84	.....	3.33	14.48
Paltacalo	0.03	3.43	0.34	0.01	1.82	.....	12.32
Peru	4.70	12.48	0.14	2.74	0.01	2.89	.....

bones of the arm, indicating that stature shows greater changes than bodily proportions, which is, of course, well known. Yet even in absolute size there is very little difference between the Munsee, Arkansas, and Louisiana; only the Peruvians have a significantly smaller femur than any of the other groups with which they are here compared. Similarly, the only significant differences in the radio-humeral index are found between the Peruvians and one other series.

The fact that bodily proportions may change significantly from race to race makes one hesitate to determine the stature by formulae or tables constructed on the basis of European material. They are bound to lead to divergent results according to which bone is used, and it is, moreover, doubtful whether the proportion between any long bone and stature remains unchanged from race to race. Thus Stevenson (1929) was actually able to show that Pearson's formulae (1898) for predicting stature are not applicable to the northern Chinese. That Pearson's formulae lead to inconsistent results for the American Indians the reader can easily verify for himself; we do not give them, since tabling them in full might be misleading.

As a general result we find that the proportions of humerus and radius show no significant differences among the various tribes of North America which we have been able to put together. There is good reason to assume, however, that the Peruvians have a definitely shorter radius than some North American Indians, while the Paltacalo from Ecuador resemble the latter closely in this respect.

Turning to the individual long bones, we can analyze only those few characters for which sufficient data are available. We are thus restricted to a consideration of the indices of the cross sections of the middle of the humerus, of the platymeric region and of the middle of the femur, and of the platycnemy of the tibia.

The midshaft index of the humerus, given only for five (mostly very short) series in R. Martin's "Lehrbuch," has of late, mainly thanks to Hrdlicka's work, received increased attention. It may be worth while, therefore, to include in our survey non-American groups.

The mean values are put together in Table 4A; they are all for right male bones, excepting the Ainu, for whom the mean for both right and left bones was given by Koganei. Unfortunately no value for the standard deviation of this index, based on a sufficiently long series, is available. The only series given in a suitable form for its computation are the thirty indices found in Miyamoto's (1926) figures. We obtain from these $\sigma = 5.49$, and, using this value

TABLE 4A.—MIDSHAFT INDEX OF RIGHT MALE HUMERUS

	Mean	Number of individuals	Author
Pecos Pueblo	72.9	146	Hooton
Munsee	73.3	14	Hrdlicka
Arkansas	74.4	10	Hrdlicka
Northern Chinese	75.7	20	Black
Ainu[1]	76.5	46	Koganei
Louisiana	76.8	18	Hrdlicka
Japanese	78.0	30	Miyamoto
Mediaeval Norwegians	79.2	161	Wagner
Irish	81.3	68	Hrdlicka
Germans	82.4	114	Hrdlicka
Italians	83.2	70	Hrdlicka

[1] Both sides.

TABLE 4B.—VALUES OF FUNCTION α FOR MIDSHAFT INDEX OF RIGHT MALE HUMERUS GIVEN IN TABLE 4A

	Pecos	Munsee	Arkansas	Louisiana	Ainu	N. Chinese	Japanese	Norwegians	Irish	Germans	Italians
Pecos	...	0.07	0.69	8.09	14.84	4.58	21.48	84.70	108.60	191.64	166.52
Munsee	...	...	0.23	3.20	3.65	1.57	6.99	14.88	24.65	34.25	37.93
Arkansas	...	...	...	1.23	1.21	0.37	3.23	7.19	13.77	19.52	22.48
Louisiana	...	...	...	....	0.04	0.38	0.54	3.10	9.55	16.16	19.35
Ainu	...	...	...	....	.....	0.29	1.35	8.66	20.96	37.88	41.37
Northern Chinese	...	...	...	....	.....	....	2.11	7.23	16.07	25.36	29.02
Japanese	...	...	...	....	.....	....	.....	1.21	7.52	15.24	18.83
Mediaeval Norwegians	...	...	...	....	.....	....	.....	.....	7.01	22.70	25.93
Irish	...	...	...	....	.....	....	.....	.....	......	1.70	4.13
Germans	...	...	...	....	.....	....	.....	.....	......	......	0.92
Italians	...	..	...	....	.....	....	.....	.....	......	......	......

for the determination of the function a, we arrive at the figures given in Table 4B. The material falls into three groups: the American Indians form one; the eastern Asiatics and the mediaeval Norwegians, the second; and the modern Europeans, the third. But these groups are far from being clear-cut; there are "gradations" all the way, and it is possible to go from the Pecos Pueblo to the Italians without ever making a statistically significant jump. The reader has only to follow the lowest oblique line from left to right to convince himself of this. Thus, while significant differences undoubtedly can be found, it seems hardly possible to arrive at a satisfactory racial classification on the basis of this index. It should be noted, however, that it is lower in North American Indians than in the populations of either eastern Asia or western Europe and that no significant differences between groups from North America are thus far to be found.

Turning to the femur, Table 5A brings together the material known for the American Indians, and Table 5B the values of the function a for the platymeric and the pilastric indices. The mean of right and left had to be used since this was the figure given for the Paltacalo. For both computations the value of the standard deviation was taken from Hooton's work on the Pecos Pueblo. For the platymeric index 6.00 was used, the value for the right side differing from that of the left (6.01) by only 0.01. For the pilastric index, the squares of the right and left sides were found and the root of their weighted mean determined (8.05). The interesting and somewhat surprising result emerges from Table 5 that the degree of platymery and pilaster shows only statistically insignificant changes in the groups from North America and Ecuador but that the Peruvians differ significantly from all the rest. We may add that the index of robusticity obviously does not change within the races given in Table 5.

There is but one character of the tibia which has been investigated in the series with which we are dealing here; namely, the degree of flattening of the shaft known as platycnemy. Unfortunately, this has been determined by American authors at the middle of the shaft, and by French authors at the level of the foramen nutritium. Only Hooton has given both. (Although distinctly different from each other, one technique is probably as good as the other in itself, but it must be admitted that the French authors are able to measure even fragments on which the middle can no longer be accurately determined.)

TABLE 5A.—MEANS OF MALE FEMUR OF AMERICAN INDIANS

		Pecos	Arkansas	Louisiana	Munsee	Peru	Paltacalo[1]
Maximum length	R	427.2(142)	....	....	458.0(14)	397.8(44)	412.7(61)
	L	426.7(140)	....	....	463.0(15)	401.5(46)	
Oblique length	R	423.9(145)	456 (14)	441 (19)	452.6(14)	394.1(44)	408.2(56)
	L	423.4(142)	456 (14)	442 (19)	458.2(15)	398.0(46)	
Platymeric: a.-p. diameter	R	23.2(158)	25 (15)	24 (23)	23.5(17)	20.0(52)	....
	L	23.4(157)	25 (15)	24 (23)	23.8(15)	20.2(48)	....
Transverse diameter	R	31.8(159)	32 (15)	33 (23)	32.2(17)	30.7(52)	....
	L	31.7(158)	32 (15)	33 (23)	33.3(15)	31.0(48)	....
Index	R	73.2(158)	76.7(15)	74.2(23)	73.1(17)	65.3(52)	73.2(71)
	L	73.9(157)	76.6(15)	74.6(23)	71.6(15)	65.3(48)	
Pilastric: a.-p. diameter	R	27.9(159)	....	....	29.1(17)	24.5(52)	....
	L	28.1(156)	....	....	29.0(16)	25.3(48)	....
Transverse diameter	R	24.6(159)	....	....	25.3(17)	23.6(52)	....
	L	24.4(156)	....	....	26.1(16)	24.0(48)	....
Index	R	112.8(159)	....	....	114.8(17)	104.1(52)	110.6(72)
	L	115.0(156)	....	....	111.2(16)	105.8(48)	
Index of robusticity	R	[12.4(145)]	....	....	[12.0(14)]	[12.2(44)]	12.4(54)
	L	[12.4(142)]	....	....	[12.0(15)]	[12.4(46)]	
Diameter of head	R	43.0(151)	....	....	....	43.1(52)	....
	L	42.95(154)	....	....	....	43.0(48)	....

NOTE: Indices in square brackets are indices of means; all others are mean indices.

[1] Means for both right and left.

TABLE 5B.—FUNCTION α FOR PLATYMERIC (UPPER RIGHT) AND PILASTRIC (LOWER LEFT) INDICES OF FEMUR

	Pecos	Arkansas	Louisiana	Munsee	Paltacalo	Peru
Pecos	.....	7.56	0.90	0.96	0.03	141.86
Arkansas	?	....	2.56	7.76	6.98	82.62
Louisiana	?	?	....	2.09	1.12	72.50
Munsee	0.29	?	?	.....	0.40	33.91
Paltacalo	1.79	?	?	2.53	.....	72.00
Peru	94.88	?	?	25.75	20.97	......

An inspection of Table 6A shows a fairly large range in the midshaft indices. As Table 6B shows, the Peruvians are here not nearly as far removed from the other series as they are regarding their femoral indices. Pecos Pueblo, on the other hand, shows the lowest midshaft index, the short series from Arkansas being a good second. The values of the function α are tabulated in Table 6B for both sides separately. The only clearly significant difference occurs between the Peruvians and the Pecos Pueblo for the right tibia. The fact that the difference for the left bone is insignificant probably means no more than that the samples we have are not large enough. Translated into ordinary language the odds against both Peruvians and Pecos Pueblo coming from the same population are more than 1:10,000 for the right and about 1:50 for the left side.

If we compare further the platycnemic index between Pecos Pueblo (pooling both sides) and Paltacalo, we obtain again a significant difference. It is safe to say, therefore, that there are racial differences in the degree of platycnemy among American Indians, and that the series from Pecos Pueblo is definitely more platycnemic than the two South American ones. The other North American series are too short to draw definite conclusions; it would certainly be worth while to settle this point on the basis of larger material.

This brief examination of the published material clearly shows that no single character arranges the American Indians in clear-cut and natural groups. We may try, however, to see what happens if the averages of the function α given previously are determined. The following table is based on the data given in Tables 3–6.

	Pecos	Munsee	Arkansas	Louisiana	Paltacalo	Peru
Pecos	....	5.9(6)	8.3(5)	6.3(5)	9.4(5)	67.7(5)
Munsee	....	......	2.3(5)	2.4(5)	15.5(4)	33.4(5)
Arkansas	....	......	......	2.3(5)	23.9(3)	39.8(4)
Louisiana	....	......	......	......	13.2(3)	37.2(4)
Paltacalo	....	......	......	......	....	27.1(4)
Peru	....	......	......	......	....	....

It is readily admitted that averages based on three to six observations do not mean very much. Yet they lead to a grouping, at any rate in this case, which is not at all unreasonable. The North American Indians all fall into one group; the Ecuador and the Peruvian populations each take a separate place. Thus, it appears possible to base racial comparisons on about twenty to thirty skeletal characters. While it is not to be expected that such a test will be as sensitive as craniological methods, it may be useful for that very reason if a broader classification is desired.

TABLE 6A.—MEANS OF MALE TIBIA OF AMERICAN INDIANS

		Pecos	Arkansas	Louisiana	Munsee	Paltacalo	Peru
Maximum length	R	357.7(130)	385 (7)	371 (13)	385 (12)	343.7(42)	322.6(30)
	L	357.8(117)	383 (7)	370.8(13)	388 (12)		327.3(26)
Transverse diam. at middle	R	20.5(146)	22 (9)	22 (17)	21.4(14)	....	18.9(29)
	L	20.1(146)	22 (9)	22 (17)	21.6(15)	....	18.7(24)
a.-p. diameter at middle	R	32.7(146)	34.5(9)	33 (17)	32.8(14)	....	27.3(29)
	L	32.9(146)	35.0(9)	33 (17)	32.3(15)	....	28.3(24)
Index at middle	R	63.0(146)	63.7(8)	68.5(17)	65.4(14)	....	69.4(29)
	L	62.8(146)	63.6(8)	68.5(17)	67.1(15)	....	66.4(24)
Trans. platycnemic diam.	R	21.5(142)	....	....	....	....	....
	L	21.6(143)	....	....	....	....	....
a.-p. platycnemic diameter	R	35.4(142)	....	....	....	....	....
	L	35.5(144)	....	....	....	....	....
Platycnemic index	R	61.2(141)	....	....	....	66.1(45)	....
	L	61.1(142)	....	....	....		....

TABLE 6B.—MIDSHAFT INDEX OF TIBIA. FUNCTION α BETWEEN SERIES GIVEN IN TABLE 6A

Upper right half: right side. Lower left half: left side

	Pecos	Arkansas	Louisiana	Munsee	Peru
Pecos	....	0.08	9.89	1.60	21.51
Arkansas	0.11	....	2.67	0.32	4.41
Louisiana	6.94	2.83	....	1.55	0.21
Munsee	5.43	1.38	0.29	....	3.28
Peru	6.01	1.02	0.95	0.10	.....

α for platymeric index of Pecos Pueblo (R and L) and Paltacalo: 20.18.

Turning now to our own material, the record of the measurements will be found in the appended tables. In order at least to indicate the position of the American Indians among the races of mankind, we shall cite non-American material more freely, although we shall generally not attempt a thorough statistical analysis of these data.

There are three male and nine female humeri, but since in many cases only one side is preserved, no mean is based on more than seven bones. The humeri are quite robust; their muscular attachments are generally well developed, particularly, of course, in the male bones. The intertubercular sulcus is throughout almost straight, closely resembling what Klaatsch (1910) more than twenty years ago was pleased to call the "orangoid" type. A perforation of the fossa olecrani was found only twice, each time on a left bone. Since the males are so definitely in the minority we have to confine ourselves to the female bones.

Some means are given in Table 7. That the lengths differ from race to race need hardly be commented upon and since the midshaft index has already been discussed, we can dismiss this character, too. These means have been included here mainly in order to show that the Lowry humerus resembles the Pecos Pueblo one quite closely. The primitive races have rather more robust bones than the mediaeval Norwegians. While it might be well to bear in mind Wagner's (1927) statement that he has sexed his material less by the size of the articular surfaces than by the general robusticity of the bones, the difference between Wagner's males and females is of the same order as that found, e.g., by Sarasin (1916–22) in his Loyalty material. We find:

	Males	Females	Ratio
Sagittal diameter of head:			
Norwegians	48.5	43.2	1.123
Loyalty	43.8	38.9	1.126
Index of robusticity:			
Norwegians	15.4	14.8	1.041
Loyalty	20.4	18.0	1.133

The sexual difference therefore is greater in Sarasin's than in Wagner's material.

The angle of torsion has been determined here approximately in the same way as Sarasin (1916–22) did (omitting, however, a camera). The axes of the head and of the trochlea were marked and the bone then clamped in the "Kubus Kraniophor," the long axis horizontal. By means of a scribe-awl, the bone was adjusted

Table 7.—Female Humerus

	Lowry	Pecos Mean	Pecos σ	Peru	Japanese	Mediaeval Norwegians	New Caledonia	Loyalty
Right Side								
Maximum length	287.4(5)	288.9(96)	13.35	269.2(13)	272.9(98)	312.7(158)	287.7(10)	294.0(14)
Maximum diameter at middle	21.6(6)	21.8(107)	1.54	....	....	21.1(158)	....	....
Least diameter at middle	14.5(7)	14.8(107)	1.07	....	....	16.2(158)	....	....
Circumference	55.9(7)	....	.....	48.8(13)	....	46.4(142)	....	....
Index of robusticity	19.3(5)	....	.....	18.1(13)	20.1(37)	[14.8(142)]	19.1(10)	18.0(14)
Midshaft index	67.7(6)	[67.9(107)]	.....	....	75.7(10)	[76.8(158)]	....	....
Angle of torsion	160°.3(6)	....	.....	....	164°.3(50)	165°.0(140)	143°.3(10)	146°.1(13)
Left Side								
Maximum length	290.5(4)	285.1(87)	12.30	268.0(9)	....	308.2(154)	288.0(8)	291.9(14)
Maximum diameter at middle	21.2(7)	21.4(95)	1.44	....	....	20.7(154)	....	....
Least diameter at middle	14.4(7)	14.6(95)	1.17	....	....	16.2(154)	....	....
Circumference	54.6(7)	....	.....	48.1(9)	....	45.6(136)	....	....
Index of robusticity	18.7(4)	....	.....	17.9(9)	....	[14.8(136)]	19.2(8)	18.3(14)
Midshaft index	67.9(7)	[68.2(95)]	.....	....	....	[78.3(154)]	....	....
Angle of torsion	163°.3(5)	....	.....	....	....	156°.9(134)	146°.9(7)	153°.8(13)

in such a way that the trochlear axis and the long axis of the bone (which is ill-defined, and was determined by "inspection") were parallel to the marble plate on which the craniophore rested. The craniophore was then tilted by 90° and on an underlying paper one of its edges (which was now parallel to the trochlear axis) was drawn, and, by means of the perigraph, the end points of the axis of the head were plotted. For further comparative material the reader is urged to turn to R. Martin's table on page 1106 of his "Lehrbuch." There cannot be the slightest doubt as to the phylogenetic value of this character when comparing man with other primates or with still lower forms. At the time of Paul Broca's death half a century ago, it was believed that the angle of torsion could be used for arranging the races of mankind in a natural, ascending sequence. It seems much less certain now. Already in Martin's table the Cibola Indians are close to the Alamans of central Europe, and the Paltacalo Indians even precede the latter. We tabulate once more the known values of American Indians, and a few others, mainly after Martin's table, pooling right and left side and both sexes.

Table 8.—Angle of Torsion of Humerus, Right and Left

Males and Females

Lowry	163.4(12)	Santa Rosa	153.1(8)
Parisians	161.5(83)	Sioux	152.9(30)
Salado	159.3(41)	Peruvians	150.2(43)
Cibola Indians	154.3(43)	Fuegians	143.9(10)
Indians (Lower California)	153.9(23)	Melanesians	139.0(14)
		Paltacalo	138.5(64)

Whether the other measurements of the humerus recorded in the Appendix (Table B) will ever be of any use is hard to predict. We are by no means convinced of it. The proximal and distal breadths differ, of course, in absolute values but we have noticed very little change from race to race in an index formed out of either one of them and the maximum length. However, our samples may have been too few, and since we are ignorant of the standard deviation of these indices, no valuable purpose is served in running headlong up a cul-de-sac. The writer's sentiment toward the trochlear measurements is the same. He still has somewhat higher hopes for the index of robusticity but so long as we do not have a series of about one hundred bones of one side and one sex and know its standard deviation, we shall not be able to make any statements of scientific value.

Some of the characters of the radius are given in Table 9, where they are at once compared with some other races published later than Martin's "Lehrbuch." The male sample from Lowry has a somewhat longer radius than the people of Pecos Pueblo, but the female means of the two groups are very close to each other. The midshaft index, not given for the Pecos Pueblo, is apparently not much different from that of the Japanese, although somewhat higher than for the male Norwegians. The scarcity of the material, however, renders a deeper study hardly worth while. The Lowry radii appear to be the least robust of all the groups with which they are here compared. The weighted mean of all four figures (16.3) coincides with that given by E. Fischer (1906) for the Burmese, the lowest of his list. This "gracility" of the Indian radius becomes still more interesting when it is recalled that for the humerus this character showed by no means the same behavior (cf. Table 7).

The information about the ulna is scanty since few bones are well preserved. Indeed, only for the right male bones can averages be based on more than two or three observations. In Table 9, we give the more important ones, with some comparative material. Here, just as for the radius, our sample shows a particularly low index of robusticity. The index of the cross section of the shaft varies little among the three series of our table. It is to be regretted that little comparative material for the breadth index of the radial half of the articular facet is available. From Fischer's (1906) table (which contains means of right and left and male and female bones) it would appear to vary significantly from race to race. It may be noticed, at any rate, that the value for all Lowry ulnae (Table D, 54.1) is very close to that given by Fischer for five Fuegians (53). The writer regrets not to have measured platyleny, but he was unable to find a workable definition of the sagittal diameter. "Perpendicular to the transverse diameter taken at the lowest point of the incisura radialis" still allows this diameter to have any angle to the long axis of the ulna, however that may be defined. But even a slight variation of this angle will influence the diameter considerably, and it was therefore felt that no faith could be placed in the results of such measurements. The shape of the shaft of the ulna varies considerably in our sample. The female bones are generally more or less triangular, while most of the male bones show quite deeply fluted shafts. There are very pronounced smooth grooves at the origins of the Mm. abductor and extensor pollicis

Table 9.—Bones of Forearm

Radius

		Lowry	Pecos Mean	Pecos σ	Japanese[1]	Mediaeval Norwegians Mean	Mediaeval Norwegians σ	Peru	New Caledonia	Loyalty
					Males					
Maximum length	R	249.8(4)	239.6 (91)	13.25	222.2(142)	253.8(89)	11.60	221.8(28)	249.5 (11)	251.4(8)
	L	248.5(2)	238.35(100)	13.15	....	252.3(93)	15.19	223.8(21)	244.0 (11)	249.1(10)
Physiological length	R	235.0(4)	....	.....	209.0(142)	238.1(89)	.....	210.0(28)	233.9 (11)	236.4(8)
	L	233.2(2)	....	.....	....	236.8(93)	.....	211.5(21)	228.9 (11)	234.4(10)
Shaft index	R	69.7(5)	....	.....	70.3(30)	[65.9(89)]	.....	....	....	....
	L	75.1(2)	....	.....	70.9(30)	[69.1(93)]	.....	....	....	....
Index of robusticity	R	16.1(4)	....	.....	20.6(64)	[19.5(88)]	.....	17.4(28)	17.9 (12)	17.4(8)
	L	16.2(2)	....	.....	....	[19.2(92)]	.....	16.8(21)	18.7 (11)	17.1(10)
					Females					
Maximum length	R	221.2(2)	219.4 (68)	10.50	200.5(98)	236.4(83)	14.40	....	226.9 (7)	227.5(11)
	L	223.0(1)	216.6 (57)	10.95	....	230.1(88)	13.43	....	226.6 (8)	225.9(10)
Physiological length	R	206.3(3)	....	.....	189.6(98)	222.6(83)	.....	....	213.2 (7)	213.4(11)
	L	210.0(1)	....	.....	....	216.5(88)	.....	....	214.1 (8)	212.5(10)
Shaft index	R	69.1(5)	....	.....	66.1(20)	[69.9(83)]	.....	....	....	....
	L	65.2(2)	....	.....	65.6(20)	[68.4(90)]	.....	....	....	....
Index of robusticity	R	16.5(3)	....	....	19.3(37)	[17.7(83)]	.....	....	17.4 (7)	17.4(11)
	L	16.7(1)	....	.....	....	[17.9(90)]	.....	....	17.25(8)	16.6(10)

Right Ulna

	Lowry	Pecos Mean	Pecos σ	Japanese[1]	Mediaeval Norwegians Mean	Mediaeval Norwegians σ	Peru	New Caledonia	Loyalty
				Males					
Physiological length	236.5(5)	....	.....	209.2(142)	241.8(80)	.....	216.0(28)	236.3 (16)	241.4(7)
Index of robusticity	14.3(5)	....	.....	17.7(64)	[17.2(80)]	.....	15.4(28)	15.5 (16)	15.3(7)
Index of cross section	79.7(6)	....	.....	79.5(10)	[77.1(78)]	.....	....	....	....

[1] After Nishizuka; midshaft index and index of cross section after Miyamoto.

and at that of the M. extensor indicis proprius. The reader who has Miyamoto's (1926) paper at hand may examine on his Table 6 the female No. 1 and the male No. 4*r*.

Coming to the femur, we give some of the mean indices for the female bones (there are too few male bones to warrant averages) in Table 10, again together with some non-American groups. Only those indices are included for which sufficient data from Lowry were available. The platymeric and pilastric indices have been extensively investigated by Pearson and Bell (1919). We refer the reader to their tabulations (*loc. cit.*, pp. 253 and 254) and to their discussion. Regarding the popliteal index and the index of popliteal skewness, the differences between the Lowry and the English femora are significant in spite of the small number of cases in the first sample, as the reader can easily verify, using Pearson and Bell's value for the standard deviations (5.673 and 3.814 respectively). For the index of robusticity we obtain, between Pecos Pueblo and English, $\alpha = 23.00$. Similarly, for the index of upper gracility we obtain for α, between Norwegians and English, 26.03. In both cases, therefore, significant differences occur. Not much can be said about the robusticity of the head, but these few remarks may have shown that a more detailed study of the femur may provide a valuable check on racial classifications arrived at by other methods.

Table E (pp. 189–192) contains data about the posture facet, the trochanter tertius and other characters. To work out percentages on such small material is superfluous, if not positively misleading. Attention should be called to a pathological condition found in one femur: a deep pit just above the patellar groove of the distal articular surface (Plate LXXXVIII), probably a sign of a tuberculous infection.

We come finally to the tibia. The value of the cnemic and the midshaft index (practically the only ones, either of which is consistently given by the authors) for differentiating between American groups has already been discussed. We give now in Table 11 further figures pertaining to non-American groups. For an exhaustive list the reader is again referred to Martin's "Lehrbuch," pp. 1158–1159. The differences between the Lowry ruin and the Pecos Pueblo are neither on the right nor on the left side significant. Since we have already seen that the Pecos Pueblo differed in the cnemic index from other American Indians, this can be regarded as an indication of the racial affinities of the Lowry material. It will further be

TABLE 10.—SOME INDICES OF THE RIGHT FEMALE FEMUR

	Lowry	Pecos	Japanese	Mediaeval Norwegians	English	New Caledonians	Loyalty
Platymeric index	73.35(8)	72.3(118)	75.5(69)[1]	81.8(249)	84.1(179)	78.2(8)	81.05(10)
Pilastric index	112.2 (7)	109.2(116)	99.8(79)	102.8(249)	103.9(185)	113.8(8)	120.2 (10)
Popliteal index	80.05(6)	....	49.6(10)?	....	67.1(181)	....	....
Index of popl. skewness	98.5 (6)	....	....	....	90.2(179)	....	....
Index of robusticity	12.25(6)	[12.2(116)]	11.9(10)	12.1(247)	12.7(160)	....	....
Distal breadth ratio	16.9 (5)	....	....	....	17.3(99)	....	....
Index of upper gracility	82.3 (8)	[78.1(116)]	....	85.6(249)	88.5(119)	....	....
Index of lower gracility	70.2 (7)	....	....	....	69.7(180)	....	....
Robusticity of head	19.1 (5)	....	21.1(10)	20.3(247)	20.3(115)	18.7(7)	19.4 (7)

[1] Only Koganei and Shiino.

noticed in Table 11 that Snell's (1934) Javanese (male, 74.1; female, 76.0) are far from Bello y Rodriguez' (1909) Malays (male, 66.6), and that our European neolithics (male and female, 63.6) differ somewhat from Bello y Rodriguez' (1909) male value, 65.2 (males alone should be lower than a mean computed from both sexes). The value for the Norwegians is astonishingly high. Taking the weighted mean of the difference between the cnemic and the mid-shaft index for Pecos Pueblo and the Japanese (1.9), we arrive at an estimate for the Norwegian cnemic index of R 78.0 and L 76.4.

TABLE 11.—INDICES OF FEMALE TIBIA

	Cnemic index R	Cnemic index L	Midshaft index R	Midshaft index L
Lowry	63.8 (9)	62.2(9)	65.9(3)	67.7(3)
Pecos	64.7 (100)	64.6(103)	66.3(104)	66.1(107)
Japanese	71.5(48)		75.2(41)	
Mediaeval Norwegians	....		79.9(277)	78.3(261)
Dutch[1]	*72.7(43)*		....	....
Javanese[1]	76.0(45)		....	....
New Caledonia	66.15(6)	64.3(7)	....	....
Loyalty	66.3 (14)	64.7(16)	....	....
European neolithics	*63.6(344)*		....	....

[1] After Snell (1934).

NOTE: *Italic* = males and females.

The races here tabled fall clearly into three groups: Oceania and America from 63.8 to 66.3, the Japanese and Dutch with 71.5 and 72.7, and finally the Javanese and Norwegians about 76.0. How unsatisfactory this is the reader will see at once for himself. Moreover, Martin's much longer table shows an almost continuous interracial distribution without any apparent order. The value for our first group (64.9 is the weighted mean) is fairly close to that given here for west European neolithics. (This is the weighted mean of several series assembled by the writer previously [1935, p. 211]. The only significant difference [α = 11.74] was found between Montigny-Esbly and the Grotte des Fées. For the rough survey intended in Table 11 they have none the less been pooled.) The remarkable change of this index in Europe within the last 5,000 years, i.e. within the last 150 generations, presents as interesting a problem as the change of the platymeric index.

THE SKULL

(Figs. 48–52; Plates LXXXIX–XC)

A survey of the craniology of the American Indians from already published material is being prepared by G. M. Morant and the

writer, and the reader may be referred to that forthcoming paper. Suffice it to say here that it could be shown by the method of the Coefficient of Racial Likeness that there are two racial groups in the Southwest, the Basket Makers and the Pecos Pueblo. It could further be shown that the former are closely related to the Peruvians and somewhat more remotely to the Californians, while the latter show some affinity to the Indians from Illinois and Virginia, as well as to the Old Zuñi. The conclusions regarding the Pecos Pueblo agree with the results reached by Hooton in his original analysis of this material. He recognized as some of the morphological types in his material a Basket Maker type and a Plains Indian type. The other types he has been led to introduce, such as pseudo-Negroid, pseudo-Australoid, pseudo-European, carry the analysis beyond the American continent and touch upon questions far more deep-lying than it is intended to discuss here.

For our present purpose it is important to know that any skull found in the Southwest may belong either to the Basket Maker or the Pecos Pueblo type, and that the latter may be regarded as intermediate between the former and the Plains Indian type.

As we have already seen in the Introduction, the value of the Lowry skulls for racial diagnosis is seriously reduced by the fact that they are deformed and that consequently most measurements of the brain box are useless for comparative purposes. Those of the face remain, but many of them are so highly correlated with others that this restricts uncomfortably the number of measurements which can be used. We have selected here, in the first place, the fundamental facial triangle and have taken G'H, LB and the nasion angle N$\angle$ as the data to be included. Of breadth measurements the orbital O_1'R and the bizygomatic breadth J have been taken. The nasal breadth has been left out because it does not differentiate the racial types with which we are here concerned.

For each skull we can give for each of the five characters the difference between its value and the means of the three series with which we compare them here, and we can form a generalized measure of resemblance for each skull by giving the average values of the differences. Expressed in a formula this measure would be defined as

$$\beta = \sum_{1}^{m} \frac{|X_i - O_i|}{\sigma_i}; i = 1 \ldots m$$

Table 12A gives the male means of the three groups and Table 12B the coefficients β for the male Lowry skulls. All four skulls are

sufficiently close to the Pecos Pueblo series to warrant the conclusion that they belong racially to this group. Yet there are minor differences. It will be seen that for each skull the lowest value is for a different group.

TABLE 12A.—MALE MEANS

	Basket Makers	Pecos (total)	Plains Indian type from Pecos	σ, "E" series
G'H	73.8	72.9	75.7	4.15
GL	96.7	97.8	98.5	4.85
LB	98.9	101.9	103.6	3.97
J	134.8	138.6	139.8	4.57
O_1'R	38.0	39.9	40.5	1.67
N∠	66°.2	65°.6	64°.5	3°.31

TABLE 12B.—VALUE OF COEFFICIENT β FOR MALE SKULLS

Skull No.	21	22	47575	47619
Basket Makers	0.73	0.96	1.58	2.23
Pecos	1.22	0.62	0.95	1.49
Plains Indians	1.63	0.90	0.70	1.35

Since all our skulls were deformed, it appeared promising to analyze their shape in greater detail. Deformation in the Southwest was a comparatively simple and in all likelihood quite unintentional affair, due to no more than a hard cradleboard, to which the babies were firmly strapped and which exerted a pressure on the occiput, centered apparently in the obelionic region.

The best way to analyze the character of this deformation would be to compare the contours of these skulls with those of undeformed ones of the same race. Unfortunately, no contours have been given for the Pecos Pueblo, and we are therefore thrown back on more indirect methods. We can either compare various measurements on the contours with the same ones in other races, or we can compare a contour as a whole with that of undeformed skulls of a similar type. In this case it should be borne in mind that we are not quite sure that the undeformed skulls from Pecos Pueblo form a random sample of that population. Hooton has pointed out that a brachycephalic skull will have a greater chance of being occipitally flattened on the cradleboard than a dolichocephalic one, which will be more prone to fall on one side.

The first part of our analysis is shown in Table 13, where a restricted number of indices and angles of two male and one female skull from Ackmen are compared with the male range of racial means given by Morant (1931). In many cases the value for an individual skull fell outside this interracial range, but it was not clear whether this was a significant deviation or not. An intraracial standard deviation was needed to determine this. It was obtained

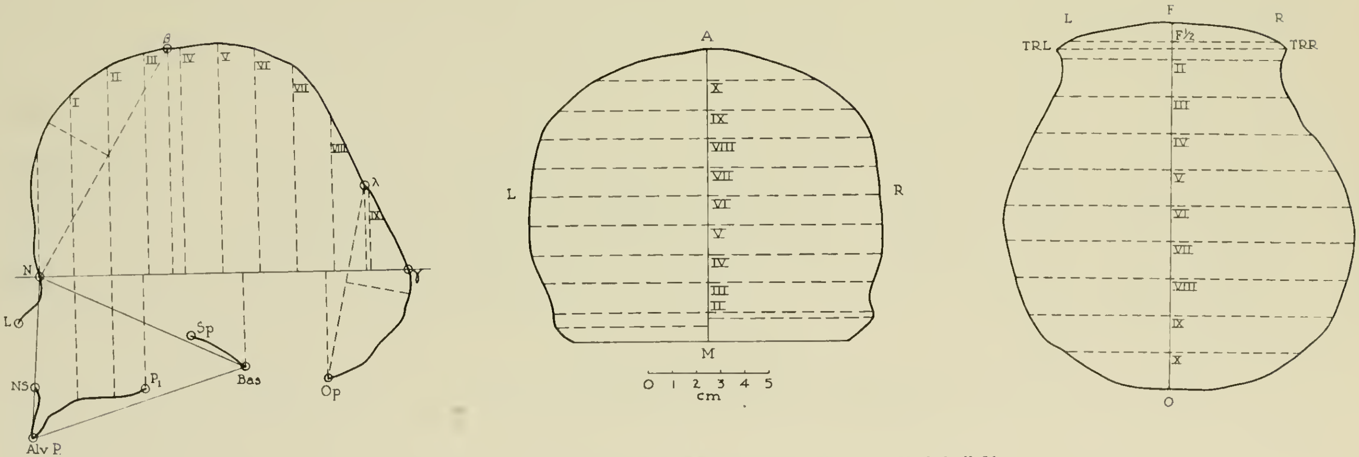


FIG. 48. Mid-sagittal, transverse, and horizontal contours of skull 21.

TABLE 13.—MEASUREMENTS FROM CONTOURS

(*For explanation, see text*)

	Lowry No. 21♂	Lowry No. 22♂	Lowry No. 23♀	Java (72) M[1]	Java (72) σ[1]	New Britain (62) M	α, Java–New Britain	Modern Races Range R	$\frac{R}{\sigma \text{ Java}}$
Index of transverse bulging	31.2	36.2 (2.44)	37.5 (3.23)	31.1 ± .13	1.64 ± .09	37.4	491.2	25.0–32.2	4.39
$\angle \beta N \gamma$	59.5 (2.28)	61.25 (2.87)	57.0 (1.43)	50.5 ± .23	2.94 ± .17	51.6	4.7	43.5–52.8	3.16
$\angle \gamma N \lambda$	14.75 (0.48)	17.5 (1.56)	12.5	12.2 ± .20	2.57 ± .14	10.3	18.2	7.8–13.5	2.22
$\angle N \lambda Op$	63.25 (4.21)	60.5 (3.15)	61.25 (3.44)	52.3 ± .21	2.60 ± .15	49.7	33.3	46.5–52.3	2.23
$\angle \lambda$ Op & Fr. H.	78.0 (3.47)	78.0 (3.47)	83.75 (4.95)	64.5 ± .31	3.89 ± .22	59.9	46.6	....	....
$100 \frac{\frac{1}{2}(TRx+TLx)}{TRy+TLy}$	11.8 (2.72)	12.6 (2.35)	17.2	17.9 ± .18	2.24 ± .13	18.7	4.2	17.9–20.9	1.34

[1] With probable errors.

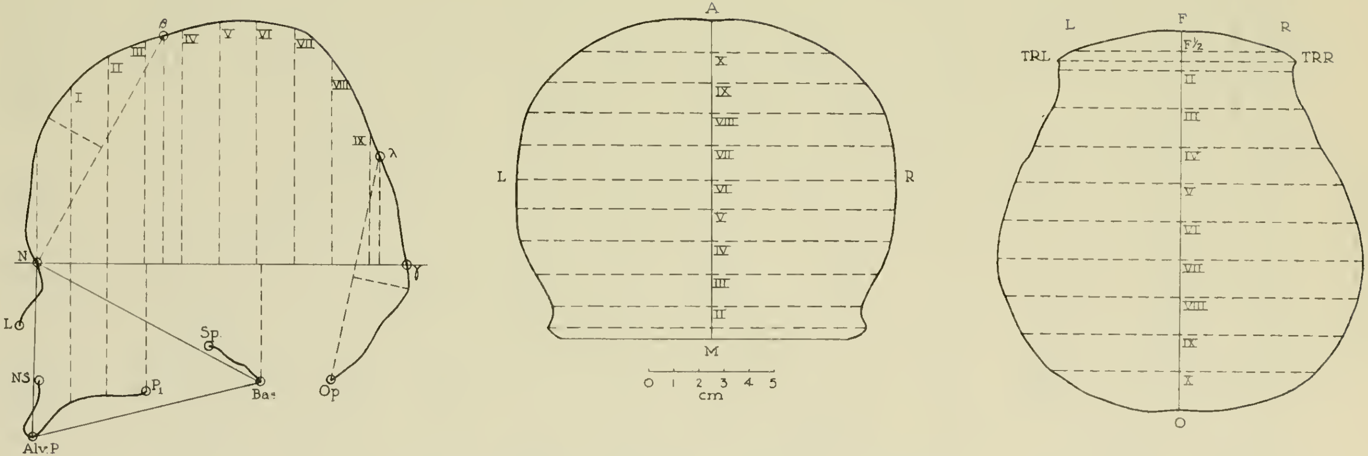


Fig. 49. Mid-sagittal, transverse, and horizontal contours of skull 22.

from a series of Java skulls, as well as from a shorter series from New Britain. In no case was there a significant difference between the former brachycephalic and the latter dolichocephalic series. Those from Java have been used for the calculations appearing in Table 13. Since we are ignorant of the values for the type contours of undeformed skulls from the Pecos Pueblo type, the distance from the extreme (highest or lowest) racial mean so far recorded to the value found for a deformed skull in terms of the standard deviation for the character in question was computed. The results are none too consistent. It is still clear that the occipital squama has been turned around in such a way as to make the acute angle between the Frankfurt Horizontal and the line joining Lambda and Opisthion significantly larger. The same thing, naturally, has happened to the angle $N\lambda Op$. That a force applied against the occiput tends to turn this bone around is nothing very startling. It would have been seen without going to all the trouble of calculation. Still, the figures reached emphasize this fact. The angle $\gamma N\lambda$ on the other hand, is evidently not influenced, nor is it likely that the occipital index is greatly changed. At any rate, the indices of our skulls are within the range of normal variation. The behavior of the parietal and frontal parts of the skull appears at first sight without any law. In the parietal region the index of bulging is within the interracial variation in one male skull but beyond the highest mean in the two others. These two have a much higher parietal breadth; a positive correlation of this index with the greatest breadth might be assumed. In the frontal region one skull shows an unusually high angle $\beta N\gamma$, indicating that the bone as a whole is tilted up, while another one shows a value of that angle which may at least be called unexpected. The female one shows nothing abnormal in this angle. On the horizontal contours the frontal bone appears rather flat. The index of flattening is very unusual in the two male skulls but stays well "within bounds" in the female one. The angle of frontal bone flatness does not in any skull exceed the highest racial mean.

More vividly than by a consideration of single characters the essential points are brought out by a comparison of contours as a whole (Fig. 52). We select the Dyak skulls (von Bonin, 1931), which are similar to the undeformed Pecos Pueblo. Comparing them we find:

	Pecos Pueblo			Dyaks		
	M	N	σ	M	N	$\alpha_{1,2}$
L	175.7	46	8.15	176.6	55	0.30
B	137.8	45	6.14	138.2	53	0.10
H′	137.1	34	6.49	134.8	47	2.47

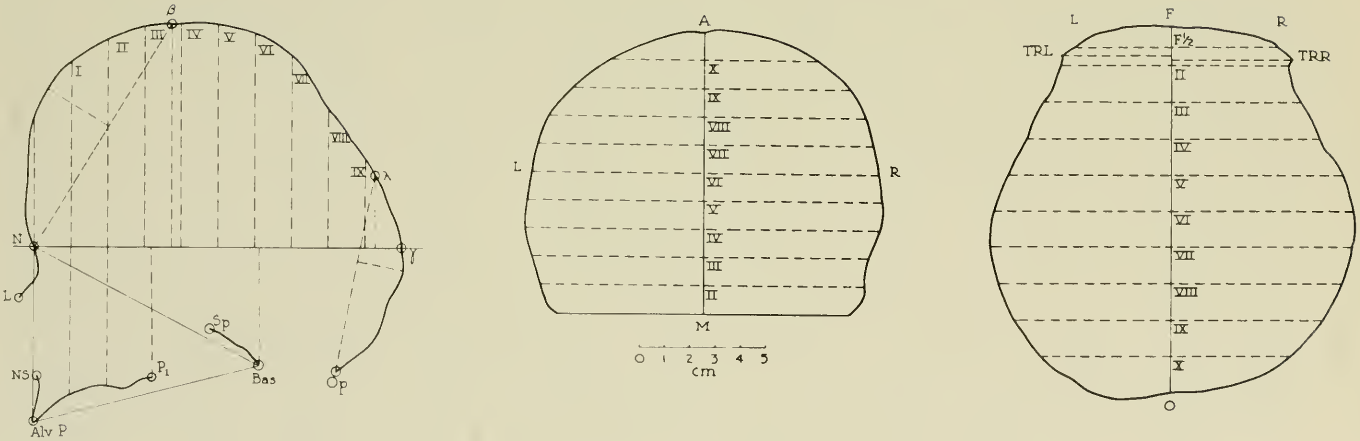


FIG. 50. Mid-sagittal, transverse, and horizontal contours of skull 23.

If the mid-sagittal contours be superimposed (Fig. 52) in such a way as to make the line Nγ and the Basion and Opisthion to coincide as nearly as possible (this latter condition, needless to say, is arbitrary; we might have chosen N and γ, e.g., instead) the tilting of the occipital bone and the flattening of the parietal at once strike the eye. The compensatory tilting of the frontal bone is also clear. The difference in the position of the alveolar point is noteworthy, but can hardly be attributed to the cranial deformation. On the transverse contour (Fig. 52) the broadening of the skull is apparent when the biporial line and the line MA are made to coincide. It is also clear that the broadening of the deformed skulls is not very pronounced at the base but that the parietal bones are blown out in a very striking manner near the level of the sixth parallel. We finally superimpose the horizontal contours (Fig. 52) in such a way that the line FO and the point F coincide. The shortening of the line FO is nothing surprising, but here again the defect in the occipital region appears to be compensated for by a blowing out of the region between the third and seventh ordinates. The flattening of the frontal bone becomes now more intelligible, too. It is simply one symptom of the general forward push. Altogether, one gets the impression that the skull is a deformable body filled with a substance following the law of hydrostatics; in plain words, that it is like a balloon filled with water. This agrees with the experience of surgeons that the brain behaves against rifle bullets exactly as an incompressible substance would.

Although most of the Lowry skulls were too fragile for the direct determination of capacities, a brief discussion of this character in deformed skulls may be permitted.

Rüdinger (1887) had found that the capacity of deformed skulls from the South Sea (these skulls are intentionally deformed by bandages, not unintentionally by cradleboard) was less than that of the normal skulls of other races. Ranke (1909) was quick to show the fallacy of this argument by comparing Rüdinger's deformed skulls with undeformed ones from the same region. Ranke even went so far as to state that undeformed skulls had less capacity than deformed ones (1151.4 against 1258.4). This was probably going too far, for, carrying out Fisher's *t*-test on the figures given by Ranke and using the variance of his samples, we obtain as a probability that the two samples came from the same population $P = .08$. In other words, there is no significant difference between the two.

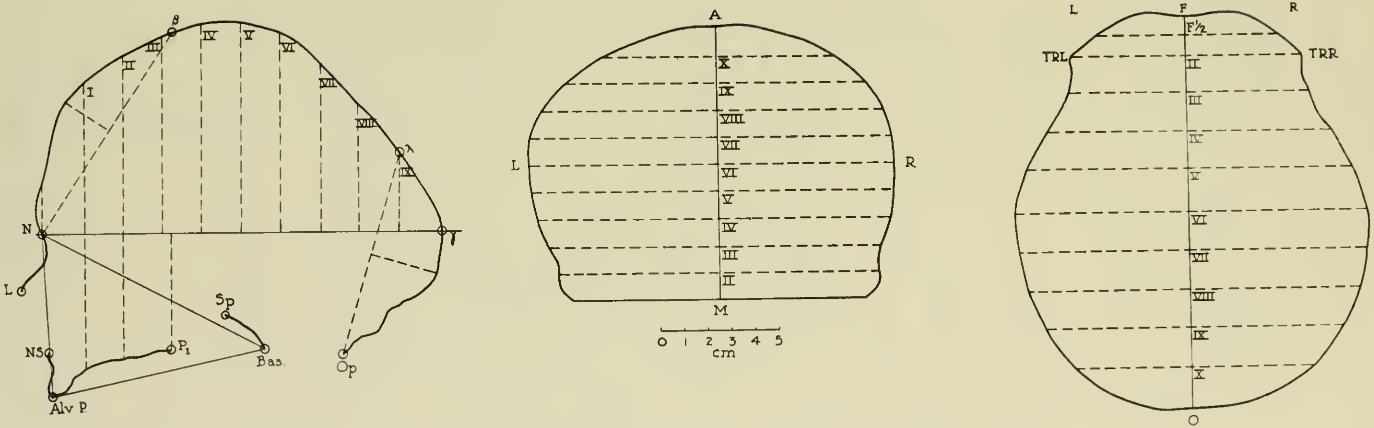


FIG. 51. Mid-sagittal, transverse, and horizontal contours of skull 47619.

It is now generally assumed that artificial deformation does not influence capacity (R. Martin, *loc. cit.*, p. 832: Schädelkapazität scheint durch die künstliche Deformation nicht beeinflusst zu werden). From America we have the following table:

Table 14.—Capacity in Deformed and Undeformed Skulls
(*With probable errors*)

	(a) Deformed	(b) Undeformed	a–b
Peru (McCurdy)			
Male	1344.1±10.05(44)	1388.2± 8.70(64)	−44.1±13.29
Female	1216.9± 9.92(41)	1216.5±10.60(39)	+ 0.4±14.52
Pecos Pueblo (Hooton)			
Male	1367.9± 8.18(68)	1338.7±14.30(31)	+29.2±16.47
Female	1254.1± 7.66(54)	1221.9±11.94(21)	+32.2±14.19

In three instances, deformed skulls have an insignificantly larger capacity than undeformed ones. If anything can be deduced from the figures from Pecos Pueblo—and that may not be justified—it is that heavier skulls have a slightly greater chance to be deformed by lying on a hard board than lighter ones: not a very startling conclusion. On the other hand, the male Peruvians show a probably significant larger capacity in their undeformed than in their deformed skulls ($\Delta/P\Delta = 3.32$). Here again, of course, it can not be decided whether smaller heads are more apt to be deformed than larger ones, or whether deformation actually arrests development of the brain. The type of deformation of the Peruvians is not that found in the Pecos Pueblo.

A remark may here be added. It was pointed out by Hooton that in the Pecos Pueblo material the cranial module = $\frac{1}{3}$ (L + B + H′) is smaller in the deformed than in the undeformed skulls; that it runs, in other words, counter to the capacities. If, however, the product L.B.H′ be formed, which, as Lee and Pearson (1901) have shown, is more highly correlated with capacity than any other character, the values agree well with the capacities as is shown by the following table:

Table 15.—Product of Diameters and Capacity in Pecos Pueblo Skulls

		Deformed	Undeformed
Males:	L.B.H′	3361	3322
	C	1367.9	1338.7
Females:	L.B.H′	3044	3025
	C	1254.1	1221.9

This indicates once more the greater usefulness of the product instead of the module for predicting capacity.

It is of some interest to compare the cranial capacities of various series, American as well as non-American. A more extensive survye

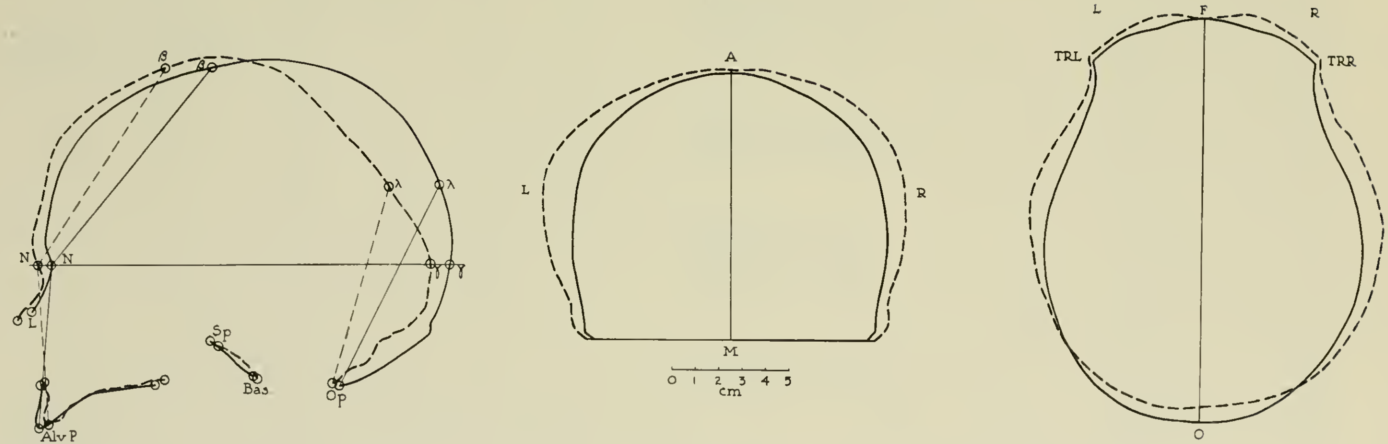


FIG. 52. Superimposed mid-sagittal, transverse, and horizontal contours of skull 17619 and Dyak male type.

was made by the writer some time ago (1934) and it was concluded that brain size as such was not of prime importance for cultural advancement. At that time the differences in stature were not taken into account but the hope was expressed that this omission would not seriously affect the results. Having now assembled some material on the long bones, the writer feels that the problem he then dismissed rather curtly might be reinvestigated, although on a much smaller scale. It was felt, with Manouvrier (1888) and Hrdlicka (1909), that the length of the femur would be an indication of stature and that a comparison of this character with cranial capacity might be useful. Table 16 gives the data.

TABLE 16.—CRANIAL CAPACITY AND LENGTH OF FEMUR

	F Oblique Length of Femur	Log F	C Capacity	Log C	$\frac{\text{Log C}}{\text{Log F}}$
Pecos	423.9	2.62726	1338.7	3.12668	1.19
Munsee	458.2	2.66106	1529.0	3.18441	1.20
Arkansas	456.6[1]	2.65954	1446.0	3.16017	1.19
Louisiana	443.7[1]	2.64709	1437.1	3.15749	1.19
Peru	398.0	2.59988	1388.2	3.14245	1.21
English	445.5	2.64885	1481.5	3.17070	1.20
Northern Chinese	440.0	2.64345	1437.6[2]	3.15764	1.19
Loyalty	431.4	2.63488	1463.0	3.16524	1.20
New Caledonia	436.9	2.64038	1420.4	3.15241	1.19

[1] After Hrdlicka, paired material.

[2] Computed, after von Bonin (1934).

The absolute measurements do not reveal much order and it has at once to be admitted that the correlation does not appear particularly close. But we may regard brain size as a problem of relative growth, in the way Julian Huxley (1932) and Eugen Dubois (1898) have approached it and compare the logarithms of the two values we have tabulated. Since neither F nor C is known exactly for more than three figures, having due regard to sampling errors, we give the quotient of the logarithms for no more than three places. They are now astonishingly uniform, although slight differences (whether significant ones or not, the writer is not prepared to assert) do occur. Thus, all the races considered here appear to have the brain size indicated by their stature.

(I first tried to compare capacity with the product of oblique femoral length and the two pilastric diameters. The quotients of the logarithms of these values are less uniform, as follows:

Peruvians	1.32
Pecos	1.27
Northern Chinese	1.27
Munsee	1.25
English	1.24

In the light of these figures, the English would have relatively the smallest brains, and the Peruvians the largest. But the problem of relative brain weight is really to find a ratio remaining constant from race to race.)

Assuredly the problem of human brain size will have to be re-examined. But even if this apparent uniformity can be confirmed, it remains none the less true that cultural achievements can not be predicted from brain size, whether absolute or relative.

CONCLUSIONS

In order to get a clear idea of the significance and of the relationships of the human remains with which this paper deals, we had to review the Indian skeletal material recorded in the literature, and in some instances even had to go beyond America. In a rough traverse we tried to get some bearings in the field of osteometry. The task of mapping out craniology was relegated to a separate publication.

Our study of the long bones showed that their length (which we have often taken as an indication of stature) and the proportions between them, as well as the shape of their shafts, showed statistically significant differences in several instances. A generalized measure of racial affinities deduced from these characters led to the inclusion of several North American Indians in one group, against an Ecuadorian and Peruvian race.

It became clear that the study of the skull led to a finer grouping than that of the long bones. On the preceding pages two aspects of cranial capacity were considered more fully: the effect of artificial deformation and the relation of capacity to the length of the femur. No definite and generally valid conclusion regarding the first problem could be drawn. While cradleboard deformation appears hardly to affect the size of the brain, undeformed skulls from Peru, where deformation is achieved by bandaging, are somewhat larger than deformed ones. Regarding the second point, it could be shown that the ratio of the logarithms of femoral length and of capacities is almost constant in the few series assembled here, and that interracially, therefore, brain size and body size appear to follow a simple law of "relative growth."

The human material described here came partly from the Lowry ruin itself and partly from other Indian mounds near Ackmen, within a radius of a mile of the Lowry ruin. Both series are very small and an attempt was made to give a statistical justification

for pooling them. In their long bones, as well as in their skulls, they are closely akin to the population of Pecos Pueblo described so fully by Hooton. A comparison with the various types recognized by Hooton in the Pecos Pueblo showed slight differences in the four male skulls of our series, thus confirming in a measure Hooton's conclusions. The artificial deformation of our skulls was analyzed more closely, and the opinion was expressed that the laws of hydrostatics are sufficient to explain its manifestations in the various parts of the skull.

APPENDIX TO CHAPTER VII

INDIVIDUAL MEASUREMENTS OF LOWRY MATERIAL

TABLES A–F

Table A.—Skull

	Glabella-occipital length	Maximal parietal breadth	Minimal frontal diameter	Basio-bregmatic height	Chord nasion to bregma	Chord bregma to lambda	Chord lambda to opisthion	Arc nasion to bregma	Arc bregma to lambda	Arc lambda to opisthion	Arc nasion to opisthion	Maximal horizontal circumference through glabella	Maximal horizontal circumference through ophryon
Biometric notation	L	B	B′	H′	S_1'	S_2'	S_3'	S_1	S_2	S_3	S	GIU	U
R. Martin	1	8	9	17	29	30	31	26	27	28	25	23	23a
					Males								
Lowry ruin													
47575	.....	155	93.0	148	105.3	.....	....	121	113	...	...	...	...
47615	.....	...	.....	.....	.....	106.0	84.2	...	122	109	...	...	...
47619	176	159	102.1	141.5	103.0	108.5	87.2	116	120	112	348	524	515
Ackmen													
21	158	147	92.0	137	108.3	97.2	83.0	126	112	105	343	491	490
22	156.5	154	95.3	145	106.2	98.1	90.0	121	118	103	342	493	493
27	172.5	...	93.0	.....	110.0	102.0	86.5	126	113	102	341	...	...
					Females								
Lowry ruin													
47614	153	144	87.0	132	94.0	97.5	83	106	111	101	318	474	472
47616	161	144	.....	139.5	100.3	97.0	83	120	105	106	331	...	...
47617	156	139	87.5	.....	102.3	102.6	....	116	115	...	...	468	470
47618	.....	...	.....	.....	.....	.....	....	121	129	...	...	...	...
47620	160	164	91.5	.....	99.5	95.0	84	121	107	113	341	508	572
Ackmen													
23	154	145	91.2	140.6	102.1	99.8	79.9	121	111	92	324	480	477
26	.....	...	88.2	.....	111.0	.....	....	125	...	...	...	...	...

TABLE A.—SKULL (*continued*)

	Vertical transverse arc from porion to porion	Arc porion to porion through bregma	Chord nasion to basion	Maximal bizygomatic breadth	Chord nasion to alveolar point	Breadth between lowest points on malar maxillary suture	External biorbital breadth	Internal biorbital breadth	Chord basion to alveolar point	Nasal height	Nasal breadth	Right orbital breadth using "curvature method"
Biometric notation	Q′	βQ′	LB	J	G′H	GB	EOW	IOW	GL	NH	NB	O_1R
R. Martin	24b	24			48	46	43	43(1)			54	
					Males							
Lowry ruin												
47575	...	...	106	140.5	76.2	105.8	105.2	95.3	92.0	52.1	23.0	45.9
47615	...	...	.....	.....	....	.....	.....	.....	....	....	....	....
47619	345	345	107	142	69.7	110.1	115	103.8	92.1	50.2	27.8	44.9
Ackmen												
21	342	337	95	133	68.2	101.0	.....	105.0	93.1	47.7	26.2	41.2
22	370	360	101.3	133	69.0	101.0	.....	108.0	94.9	42.4	26.0	42.6
27	...	...	.....	.....	68.8	90.1	.....	.....	....	48.0	22.6	40.3
					Females							
Lowry ruin												
47614	317	313	94.7	129.5	65.2	93.4	99	95.1	89.0	47.0	23.1	40.5
47616	...	...	97.3	.....	69.0	.....	.....	.....	86.3	50.0	....	40.9
47617	321	325	.....	.....	....	.....	98	89.3	....	....	....	....
47618	...	...	.....	.....	....	.....	.....	.....	....	....	....	....
47620	...	349	.....	.....	....	.....	.....	.....	....	....	....	....
Ackmen												
23	331	338	101.4	.....	69.3	100.0	.....	105.0	92.0	49.7	25.0	40.9
26	...	...	.....	.....	70.3	.....	.....	.....	....	48.3	23.2	....

TABLE A.—SKULL (*continued*)

	Right orbital breadth from dacryon	Right orbital breadth from lacrymal point	Right orbital height	Left orbital breadth using "curvature method"	Left orbital breadth from dacryon	Left orbital breadth from lacrymal point	Left orbital height	Palate length to tip of posterior nasal spine	Palate length to base of posterior nasal spine	Palate breadth between second molars	Length of foramen magnum (opisthion-basion)	Breadth of foramen magnum
Biometric notation	$O_1'R$	Lacr. O_1R	O_2R	O_1L	$O_1'L$	Lacr. O_1L	O_2L	G_1	G_1'	G_2	fml	fmb
R. Martin			52	51			52	62a	62	63	7	16
					Males							
Lowry ruin												
47575	40.8	39.0	32.2	42.0	39.1	38.2	31.9	47.2	43.2	43.0	....	30.0
47615	....	....	....	....	....	....	....	....	....	....	....	....
47619	42.5	41.2	31.8	45.1	42.9	41.1	31.1	50.2	46.0	44.9	37.2	31.9
Ackmen												
21	38.2	37.1	33.0	41.8	39.0	38.1	35.0	44.8	42.5	....	....	....
22	39.9	39.9	34.9	43.3	39.7	39.7	32.5	48.0	44.4	38.1	....	....
27	37.7	37.7	35.3	40.1	36.9	36.9	35.1	47.2	43.0	40.0	....	....
					Females							
Lowry ruin												
47614	....	37.0	32.1	41.0	....	37.0	33.0	42.4	37.0	40.2	....	....
47616	39.1	....	38.3	....	....	....	....	....	....	....	33.8	28.0
47617	....	....	....	39.0	35.0	....	36.0	....	....	....	....	....
47618	....	....	....	....	....	....	....	....	....	....	....	....
47620	....	....	....	....	....	....	....	....	....	....	....	....
Ackmen												
23	39.9	37.9	34.4	40.1	39.8	38.0	34.3	48.0	41.6	....	....	....
26	....	....	....	40.9	....	....	35.1	43.0	39.1	38.0	....	....

TABLE A.—SKULL (*concluded*)

	Cephalic index	Height-length index	Breadth-height index	Compound index	Occipital index	Upper facial index	Nasal index	Right orbital index	Palate index	Alveolar angle	Nasion angle	Basion angle	Profile angle to alveolar point
Biometric notation	100B / L	100H′ / L	100B / H′	100(B-H′) / L	Oc.I	100G′H / GB	100NB / NH	100 O_2 / O_1R	100 G_2 / G_1	A∠	N∠	B∠	P∠
						Males							
Lowry ruin													
47575	.....	....	104.7	...	....	72.0	44.1	70.2	91.1	77°.5	57°.8	44°.7	97°.5
47615	.....	....	.....	...	....	....	....	....	....	.....	.....	.....	.....
47619	90.3	80.4	112.4	9.9	....	63.3	55.4	70.8	89.4	81°.5	58°.3	40°.2	96°.0
Ackmen													
21	93.0	86.7	107.3	6.3	56.4	67.5	54.9	80.1	....	70°.3	67°.2	42°.5	.....
22	98.4	92.7	106.2	5.8	65.8	68.3	61.3	81.9	79.4	74°.5	64°.5	41°.0	.....
27	.....	....	.....	...	61.8	76.4	47.1	87.6	84.7	.....	.....	.....	.....
						Females							
Lowry ruin													
47614	94.1	86.3	109.1	7.8	....	69.8	49.1	79.3	94.8	73°.9	64°.6	41°.5	89°.0
47616	89.4	....	115.5	2.8	....	....	....	....	....	76°.7	59°.7	43°.6	.....
47617	89.1	....	.....	...	....	....	....	....	....	.....	.....	.....	.....
47618	85.9	....	.....	...	....	....	....	....	....	.....	.....	.....	.....
47620	102.5	....	.....	...	....	....	....	....	....	.....	.....	.....	.....
Ackmen													
23	94.2	91.3	103.1	3.5	64.9	69.3	50.3	84.1	....	61°.9	76°.5	41°.6	.....
26	.....	....	.....	...	....	....	48.0	....	88.4	.....	.....	.....	.....

Table B.—Humerus

Characters		Max. length	Total length	Upper epiph. breadth	Lower epiph. breadth	Max. diameter at middle	Minimum diam. at middle	Least circumference	Transverse diam. of head	Sagittal diam. of head	Breadth of trochlea	Breadth of capitulum
R. Martin No.		1	2	3	4	5	6	7	9	10	11	12
					Males							
Lowry ruin												
47575	R	331	327	48?	54?	23.2	18.3	60	....	....	42.0	....
	L	328	326.5	49	..	22.0	17.3	60	....	45.0	....	....
47615	L	313	307	50	61	22.2	16.3	61	41.3	44.6	....	....
47619	R	338	334.5	47	57	27.1	17.6	66	....	....	40.0	17.0
					Females							
Lowry ruin												
47614	R	315	313	44	54	19.3	14.3	55	38.1	39.1	38.4	14.5
	L	315	314	43	54	20.6	14.7	54	38.3	39.2	38.6	15.0
47616	R	...	.....	....	..	25.0	14.3	57	35.1	35.6	....	....
	L	...	.....	....	..	....	....	..	....	....	....	....
47617	R	271	269	44	56	20.7	14.2	55	....	....	....	....
	L	...	.....	....	..	19.6	15.0	54	36.3	39.0	37.8	15.0
47618	R	...	.....	....	..	22.8	14.3	57	....	....	36.0	15.0
	L	...	.....	....	..	21.4	14.3	57	36.0	37.2	....	....
47620	R	288	287	45	55	21.3	15.3	58	36.8	37.0	35.1	15.0
	L	284	279	44	54	21.2	15.0	57	36.2	37.3	33.?	15.0
Ackmen												
11	L	...	.....	....	..	23.6	14.3	54	36.1	38.4	....	....
14	R	280	275	43	53	23.0	14.1	54	....	38.2	36.2	14.5
23	L	276	271	42	56	20.0	13.0	52	35.0	36.2	....	....
26	R	283	282	45	55	22.2	15.0	55	38.3	40.3	40.1	15.9
	L	287	284	44.5	55	22.2	14.3	54	38.1	40.4	38.0	15.2

TABLE B.—HUMERUS (*concluded*)

Characters		Depth of trochlea	Breadth of fossa olecrani	Angle of torsion	Index of shaft at middle	Index of robusticity	Index of ellipticity of head	Trochlear breadth index	Remarks
R. Martin No.		13	14	18	6/5	7/1	9/10	11/4	
				Males					
Lowry ruin									
47575	R	28.0	....	168	78.9	18.1	....	77.8	
	L	....	....	179	78.6	18.3	....	....	
47615	L	27.0	26.6	161	73.4	19.5	92.6	....	
47619	R	28.7	26.9	...	64.9	19.5	....	70.2	
				Females					
Lowry ruin									
47614	R	24.6	26.3	151	74.1	17.5	97.4	71.1	
	L	25.2	27.2	166	71.4	17.1	97.7	71.5	Perforatio fossae olecrani
47616	R	....	....	...	57.2	....	98.6	....	
	L	23.1	24.0	...	....	....	....	....	Perforatio fossae olecrani
47617	R	25.3	....	...	68.6	20.3	....	....	
	L	26.1	27.0	147	76.5	....	93.1	....	
47618	R	24.1	25.7	...	62.7	....	....	....	
	L	....	....	...	66.8	....	96.8	....	
47620	R	24.3	24.1	169	71.8	20.1	99.5	63.8	
	L	25.3	24.3	177	70.8	20.1	97.1	61.1?	
Ackmen									
11	L	....	....	...	60.6	....	94.0	....	
14	R	27.0	25.2	157	61.3	19.3	....	68.3	
23	L	24.2	24.3	163	65.0	18.8	96.7	....	
26	R	26.9	26.2	159	67.6	19.4	95.0	72.9	
	L	25.3	25.2	164	64.4	18.8	94.3	69.1	

TABLE C.—RADIUS

Characters	Max. length	Physiol. length	Least circumf.	Transverse diam. of shaft	Transverse diam. of capitul.	Transverse diam. of collum	Sagit. diam. of shaft	Sagit. diam. of capitul.	Sagit. diam. of collum	Lower epiph. breadth	Index of robusticity	Index of shaft	Robusticity of capitulum	Lower epiph. index
R. Martin No.......	1	2	3	4	4(1)	4(2)	5	5(1)	5(2)	5(6)	3/2	5/4	4(1)/2	5(6)/2
						Males								
Lowry ruin														
47575.........R	258	243	37	16.2	20.0	14.0	12.0	19.0	15.3	33.5	15.2	74.1	8.2	13.8
L	258	243	36.5	15.1	....	13.8	10.7	21.0	15.9	33.0	15.0	70.9	....	13.6
47615.........R	.....	.....	38	16.1	....	14.0	11.3	....	14.0	....	....	70.2	....	....
L	239	223.5	39	16.4	....	13.0	11.0	20.2	14.0	34.0	17.4	79.3	....	15.2
47619.........R	267	253.5	41	19.0	23.6	14.0	12.0	23.2	13.0	33.0	16.2	63.2	9.3	13.0
Ackmen														
7............R	228	210.5	38	16.2	23.0	11.5	11.3	23.3	13.0	32.0	18.1	69.8	10.9	....
22[1]...........R	246	233	35	16.0	....	12.1	11.4	....	11.9	30.5	15.0	71.2	....	....
						Females								
Lowry ruin														
47614.........R	.....	.....	35	14.8	19.2	12.0	10.1	20.1	14.0	....	....	68.2	....	....
47616.........R	.....	.....	36	15.0	....	....	11.5	....	....	30.0	....	76.7	....	....
Ackmen														
14............R	.....	202	33	15.0	19.6	10.0	11.3	20.0	12.8	....	16.3	68.7	9.7	....
23............R	219.5	207	34	15.1	20.3	9.0	10.1	20.0	11.5	30.0	16.4	66.9	9.8	....
L	.....	.....	34	15.0	20.0	9.0	10.0	20.0	11.0	....	....	66.7	....	....
26............R	223	210	35	16.6	19.7	10.6	10.8	20.6	12.3	29.5	16.7	65.1	9.4	....
L	223	210	35	17.1	20.2	10.9	10.3	20.4	12.6	30.0	16.7	63.7	9.6	....

[1] Arthritis deformans capituli.

Table D.—Ulna

Characters	Max. length	Physiol. length	Least circumference	Breadth of olecranon	Depth of olecranon	Olecranon to coron. pr.	Height of olecranon	Anterior breadth of olecranon	Posterior breadth of olecranon	Dorso-volar diam.	Transverse diam.
R. Martin No.	1	2	3	6	7	7(1)	8	9	10	11	12
				Males							
Lowry ruin											
47575 R	.....	244	34	....	....	....	....	...	....	13.2	17.0
L	.....	242	34	....	....	....	....	5.3	8.4	12.2	16.3
47615 R	.....	230	34	....	....	....	....	5.2	11.3	12.7	16.2
L	.....	.....	34	26.1	25.0	24.0	17.9	5.1	10.7	12.7	15.6
47619 R	.....	253	37	....	....	....	....	4.2	10.1	14.0	20.0
Ackmen											
7 R	246	213	34	....	....	26.0	17.9	6.3	13.0	13.0	14.7
21 R	.....	.....	..	27.0	24.2	23.1	16.8	6.2	10.9	13.2	15.4
22 R	269	242.5	30	26.0	23.0	21.2	14.0	4.1	10.9	11.2	14.3
				Females							
Lowry ruin											
47614 R	.....	.....	30	25.6	22.2	22.0	14.1	...	....	10.9	12.0
L	.....	.....	..	....	....	....	....	6.3	8.0	10.9	12.1
47616 R	.....	.....	35	....	....	....	....	...	....	11.3	14.7
47620 R	.....	.....	..	24.0	21.2	20.3	14.3	4.9	8.3	12.0	13.4
Ackmen											
14 R	231	202	32	25.7	23.6	22.0	17.2	7.5	13.9	11.8	13.0
16 R	.....	.....	..	25.0	22.0	18.3	15.1	6.0	10.0	12.0	14.0
23 R	236	208	29	26.0	25.2	17.6	14.9	...	....	10.8	13.7
L	.....	.....	29	24.8	23.1	17.8	14.9	4.9	9.8	10.0	13.1
26 R	237.5	210	35	23.9	23.0	20.3	15.2	6.1	10.1	11.7	14.1

TABLE D.—ULNA (*concluded*)

Characters		Index of robusticity	Lengths index	Depth-breadth index of olecranon	Height-breadth index of olecranon	Breadth index of olecranon	Index of cross section	Groove for extensor poll. and indicis	Remarks
R. Martin No.		3/2	1/2	7/6	8/6	9/10	11/12		
				Males					
Lowry ruin									
47575	R	13.9	....	.....	....	....	77.6	+	
	L	14.0	....	.....	....	63.1	74.8	+	
47615	R	14.8	....	.....	....	46.0	78.4	+	
	L	....	....	95.8	68.6	47.7	81.4	+	
47619	R	14.6	....	.....	....	41.6	70.0	+	
Ackmen									
7	R	16.0	86.7	101.6	71.0	48.5	88.4	+	
21	R	....	....	89.6	62.2	56.9	85.7	+	Arthritis deformans
22	R	12.4	90.1	88.5	53.8	37.6	78.3	sl	Arthritis deformans
				Females					
Lowry ruin									
47614	R	....	....	86.7	55.1	....	90.8	sl	
	L	....	....	.....	....	78.8	90.1	sl	
47616	R	....	....	.....	....	....	76.9	..	
47620	R	....	....	88.3	59.6	59.0	89.6	?	
Ackmen									
14	R	15.8	87.4	91.8	66.9	54.0	90.8	sl	
16	R	....	....	88.0	60.4	60.0	85.7	+	
23	R	13.9	88.1	96.9	57.3	....	78.8	sl	Arthritis deformans
	L	....	....	100.6	57.3	50.0	76.3	sl	at proximal ends
26	R	16.7	88.9	96.2	63.6	60.4	83.0	sl	

Table E.—Femur

Characters		Max. length	Trochanteric length	Maximum trochanteric length	Oblique length	Trochanteric oblique length	Greatest vertical diameter of head	Greatest horizontal diameter of head	Antero-posterior platymeric diameter	Transverse platymeric diameter	Antero-posterior pilastric diameter	Transverse pilastric diameter
Pearson and Bell		a	b	c	d	e	f	g	h	i	k	l
					Males							
Lowry ruin												
47575	R	.....	.....	.....	.....	.....	....	....	24.0	35.0	31.0	28.1
	L	458	442	448.5	456	440	46.3	....	24.1	34.7	30.9	27.1
47615	R	.....	.....	.....	.....	.....	....	....	25.0	28.1	....	....
	L	438	413.5	419.5	436	413	43.8	43.3	25.0	28.2	31.1	25.1
Ackmen												
7	R	.....	.....	.....	.....	.....	38.1	37.2	20.0	28.6	....	....
21	R	.....	.....	.....	.....	.....	42.3	42.3	23.2	30.0	....	....
	L	.....	.....	.....	.....	.....	42.8	42.6	22.2	29.8	....	....
27	L	440	425	434	436	419	40.5	40.0	24.5	33.0	28.3	26.6
					Females							
Lowry ruin												
47614	R	441.5	421	430	437.5	419	40.0	40.0	21.0	29.0	25.0	24.0
	L	440	422	430	436	419.5	40.2	40.2	21.4	28.1	25.2	24.0
47616	R	418	400	406.5	415.5	.....	36.3	37.4	22.0	30.0	25.0	25.8
	L	416.5	.....	.....	414.5	.....	38.3	37.0	22.3	29.8	26.9	24.8
47617	R	383	.....	.....	379	.....	....	....	20.0	28.0	26.7	22.0
	L	.....	.....	.....	.....	.....	39.1	39.0	20.0	28.2	25.1	21.0
47618	R	.....	.....	.....	.....	.....	40.2	39.9	22.0	28.4	27.2	24.0
	L	.....	.....	.....	.....	.....	....	....	22.6	28.1	28.0	24.7
Ackmen												
9	R	410	390	398	407	386	41.3	40.0	24.1	29.6	29.0	25.0
	L	.....	.....	.....	.....	.....	....	....	24.6	29.6	28.6	25.2
23	R	389	.....	.....	384	.....	37.2	37.1	18.0	28.0	24.9	20.2
	L	392	.....	.....	388	373	37.3	37.0	18.2	28.1	24.2	20.8
26	R	397	376.5	385	393	373	39.0	38.8	20.7	27.0	25.2	22.8
	L	398	377	385	393	.....	38.8	38.8	20.9	27.0	26.0	22.3
29	R	.....	.....	.....	.....	.....	....	....	20.0	25.4	22.3	21.7
	L	400	376	384.5	397	375	39.3	39.0	19.7	27.2	24.7	22.0

Table E.—Femur (*continued*)

Characters		Popliteal length	Popliteal width	Antero-posterior popliteal diameter	Oblique antero-posterior popliteal diameter	Epicondylar breadth			Length of head and neck	Length of shaft	Collar horizontal diameter	Collar vertical diameter
Pearson and Bell		n	o	p	q	s	σ_1	σ_2	t	u	n_h	n_v
					Males							
Lowry ruin												
47575	R	...	38.4	31.3	31.8	....	63.0	63.0	....	.....	....	33.1
	L	...	40.7	33.1	32.1	80.0	63.0	....	72.5	398	25.0	33.1
47615	R	107	....	....	....	....	....	....	....	.....	....	....
	L	121	33.7	31.1	31.2	....	63.3	....	62.0	380.5	26.5	30.0
Ackmen												
7	R	...	....	....	....	....	....	....	....	.....	20.2	25.6
21	R	...	....	....	....	....	....	....	....	.....	25.0	28.9
	L	...	....	....	....	....	59.3	57.0	....	.....	24.9	28.7
27	L	144	38.4	26.3	29.0	74.0	59.3	57.1	77.0	381.5	20.4	26.7
					Females							
Lowry ruin												
47614	R	123	36.4	26.8	27.0	72.0	59.2	57.0	79.0	376	21.7	25.6
	L	124	36.1	26.0	26.3	73.0	60.2	57.0	71.0	377	21.1	26.1
47616	R	121	36.5	25.9	25.8	65.5	53.0	....	61.0	365.5	22.3	27.4
	L	128	36.3	26.3	25.9	63.0	52.2	....	....	.....	21.2	28.0
47617	R	121	31.4	25.6	27.0	....	55.8	....	....	.....	....	....
	L	115	30.0	26.1	27.0	70.5	54.0	....	....	.....	21.6	28.0
47618	R	...	....	....	....	....	....	....	....	.....	23.0	29.8
	L	...	....	....	....	....	....	....	....	.....	....	....
Ackmen												
9	R	...	36.2	30.0	30.3	69.5	....	....	....	.....	21.7	29.0
	L	...	36.3	29.8	30.0	....	....	....	....	.....	22.3	29.0
23	R	114	25.1	23.7	24.0	69	54.4	52	....	.....	....	....
	L	110	25.8	24.0	24.0	....	54.2	....	....	.....	....	....
26	R	122	33.0	25.3	25.6	70	59.3	56.4	55.5	346	20.7	27.5
	L	124	31.2	25.7	25.7	70.5	58.1	55.8	59.0	342.5	21.5	28.0
29	R	...	33.2	21.6	27.0	....	....	....	....	.....	21.3	29.1
	L	132	32.0	24.9	27.2	64	58.0	....	67	339	22.6	29.0

Table E.—Femur (*continued*)

Characters		Diaphys. length	Length of neck	Proximal breadth	Sex criterion	Platymeric index	Pilastric index	Popliteal index	Bicondylar width index	Popliteal bicondylar index	Pyramidal popliteal index	Primary capital index	First capito-collar index	Index of upper gracility	Index of lower gracility	Index of transverse tenderness	Index of sagittal tenderness
Indices						100h	100k	100p	100s	100o	100o	100g	100f	100l	100l	100h	100k
						i	l	o	a	s	r	f	t	i	o	u	u
								Males									
Lowry ruin																	
47575	R	.....	....	....	...	68.6	110.3	81.5	....	....	....	.....	....	80.3	73.2	....	....
	L	405	49.4	....	106	69.5	114.0	81.3	17.5	50.9	....	.....	63.9	78.1	66.6	6.06	7.76
47615	R	.....	....	....	...	89.0	.....	....	....	....	....	.....	....	....	.....	....	....
	L	373	40.1	88.2	...	88.7	123.9	92.3	....	....	27.9	98.9	70.6	89.0	74.5	6.57	8.17
Ackmen																	
7	R	.....	....	....	...	69.9	.....	....	....	....	....	97.6	....	....	.....	....	....
21	R	.....	....	86.0	...	77.3	.....	....	....	....	....	100.0	....	....	.....	....	....
	L	.....	....	87.0	...	74.5	.....	....	....	....	....	99.5	....	....	.....	....	....
27	L	384.5	56.8	90.3	97	74.2	106.4	68.5	16.8	51.9	26.7	98.8	51.6	80.6	69.3	6.42	7.42
								Females									
Lowry ruin																	
47614	R	382.5	59.0	87.0	95	72.4	104.2	73.6	16.3	50.6	29.6	100.0	50.6	82.8	65.9	5.59	6.65
	L	380.5	50.9	85.2	96	76.2	105.0	72.0	16.6	49.5	29.1	100.0	56.6	85.4	66.5	5.68	6.68
47616	R	368	41.8	79.1	88	73.3	96.9	71.0	15.7	55.7	30.2	97.7	62.8	86.0	70.7	6.02	6.84
	L	.....	....	....	86	74.8	108.5	72.5	15.1	57.6	28.3	96.6	....	83.2	68.3	....	....
47617	R	.....	....	....	...	71.4	121.4	81.5	....	....	26.0	.....	....	78.6	70.1	....	....
	L	.....	....	....	93	70.9	119.5	87.0	....	42.6	26.1	99.7	....	74.5	70.0	....	....
47618	R	.....	....	....	...	77.5	113.3	....	....	....	....	.....	....	84.5	.....	....	....
	L	.....	....	....	...	80.4	113.4	....	....	....	....	.....	....	87.9	.....	....	....
Ackmen																	
9	R	353	....	....	...	81.4	116.0	82.9	17.0	52.1	....	96.9	....	84.5	69.1	....	....
	L	.....	....	....	...	83.1	113.5	82.1	....	....	....	.....	....	85.1	69.4	....	....
23	R	.....	....	....	...	64.3	123.3	94.4	17.7	36.4	22.0	99.7	....	72.1	80.5	....	....
	L	.....	....	....	...	64.8	116.3	93.0	....	....	23.5	99.2	....	74.0	80.6	....	....
26	R	342	36.1	79.3	93	76.7	110.5	76.7	17.6	47.1	27.0	99.5	70.3	84.4	70.0	5.98	7.28
	L	338	39.6	79.1	93	77.4	116.6	82.4	17.7	44.3	25.2	100.0	65.8	82.6	71.5	6.10	7.59
29	R	.....	....	....	...	....	.....	....	....	....	....	.....	....	85.4	65.4	....	....
	L	322	47.4	83.0	88	72.4	112.3	77.8	17.5	50.0	24.2	99.2	58.7	80.9	68.75	5.81	7.29

TABLE E.—FEMUR (*concluded*)

Characters	Second capito-collar index 100t	Third capito-collar index 100t	Index of popliteal skewness 100p	Direct-oblique length index 100d	Direct-oblique trochanteric index 100c	Secondary capital index 100f	Fourth capito-collar index 100t	Bicondylar trochanteric index 100s	Third capital index 100f	Index of robusticity of femur 100(k+l)	Index of robusticity of head 100(f+g)	Primary index of neck $100n_V$	Secondary index of neck $100n_H$	3rd trochanter	Posture facet	Crural trough
Indices	u	s	q	a	b	a	a	b	s	d	d	n_H	g			
Lowry ruin							*Males*									
47575..R	....	.....	98.4	.....	....	......	....	....	....	....	....	....	.....		+	sl
L	18.2	90.6	103.1	99.6	98.6	10.1	15.8	18.1	57.9	12.7	....	75.5	.....		+	sl
47615..R	....	.....	.....	.....	....	......	....	....	....	....	....	....	.....			
L	16.3	.....	99.7	99.5	98.6	10.0	14.2	....	....	12.9	19.9	88.3	.....	d		
Ackmen																
7.....R	....	.....	.....	.....	....	......	....	....	....	....	....	....	54.3			
21.....R	....	.....	.....	.....	....	......	....	....	....	....	....	....	.....			
L	....	.....	.....	.....	....	......	....	....	....	....	....	....	.....			
27.....L	20.2	104.1	90.7	99.1	97.9	9.20	17.5	17.4	54.7	12.6	18.5	76.4	51.0			
Lowry ruin							*Females*									
47614..R	21.0	109.7	99.3	94.9	97.9	9.06	17.9	17.1	55.6	11.2	18.3	84.8	54.25		+	sl
L	18.8	97.3	98.9	99.1	98.1	9.14	16.1	17.3	55.1	11.3	18.4	80.8	52.5		+	sl
47616..R	16.7	93.1	100.4	99.4	98.4	9.16	14.6	16.4	58.5	12.2	18.2	81.4	59.6			
L	....	.....	101.5	99.5	....	9.20	....	....	60.8	12.5	18.2	75.7	57.3			
47617..R	....	.....	94.8	99.0	....	......	....	....	....	12.8	....	....	.....	Small	+	sl
L	....	.....	96.7	.....	....	......	....	....	55.5	....	....	77.1	55.4	Small	+	sl
47618..R	....	.....	.....	.....	....	......	....	....	....	....	....	77.2	57.6		+	sl
L	....	.....	.....	.....	....	......	....	....	....	....	....	....	.....			
Ackmen																
9.....R	....	.....	99.0	99.3	98.0	10.1	....	17.8	59.4	13.3	20.0	74.8	54.25			
L	....	.....	99.3	.....	....	......	....	....	....	....	....	76.9	.....			
23.....R	....	.....	98.8	98.7	....	9.56	....	....	54.1	11.7	19.3	....	.....			
L	....	.....	100.0	99.02	....	9.52	....	....	....	11.7	19.1	....	.....			
26.....R	16.0	79.3	98.8	99.0	97.8	9.77	14.9	18.6	53.7	12.2	19.8	75.3	55.4			
L	17.2	83.7	100.0	98.8	97.9	9.75	14.8	18.7	55.0	12.3	19.7	76.8	55.4			
29.....R	....	.....	80.0	.....	....	......	....	....	....	....	....	73.2	.....			
L	19.8	104.7	91.5	99.25	97.8	9.825	13.9	17.0	61.4	11.8	19.7	77.9	57.9			

Table F.—Tibia

Characters	Total length	Maximum length		Breadth of prox. epiph.	Breadth of distal epiph.	Sagitt. diam. of lower epiph.	Max. diam. at middle	Max. diam. at for. nutr.	Transv. diam. at middle	Transv. diam. at for. nutr.	Platycnemic index	Midshaft index
R. Martin No.	1	1a	1b	3	6	7	8	8a	9	9a	9a/8a	9/8
					Males							
Lowry ruin												
47575 ....R	388?	395	385.5	....	51.0	38.7	31.9	34.8	23.2	24.4	70.1	72.7
L	390	396	388	78.5	50.5	38.2	32.1	37.0	23.0	23.0	62.2	71.7
47615 ....R	...	...	.....	....	....	....	....	39.2	....	21.3	54.3	....
L	...	...	.....	....	....	....	....	39.0	....	21.0	53.8	....
Ackmen												
7 ....R	376	380	370	74	45.5	33.0	30.2	33.6	20.4	21.0	62.5	67.5
L	375	380	369	71	46	31.2	29.3	31.4	20.9	21.0	66.9	71.3
21 ....R	...	...	.....	....	....	....	....	35.6	....	21.7	61.0	....
L	...	...	.....	....	....	....	....	36.3	....	19.6	54.0	....
					Females							
Lowry ruin												
47614 ....R	...	...	.....	70.5	....	....	....	31.8	....	20.9	65.7	....
L	...	...	.....	71	....	....	....	32.0	....	20.6	64.4	....
47616 ....R	340	346	339.5	61.5	39.5	31.0	25.4	29.1	18.5	20.2	69.4	72.8
L	...	...	.....	61	....	....	26.3	29.3	20.0	20.1	68.6	76.0
47617 ....R	...	...	.....	....	....	....	27.0	30.0	17.3	19.4	63.7	64.1
L	...	...	.....	....	....	....	....	30.0	....	18.0	60.0	....
47618 ....R	...	...	.....	....	40.5	31.1	....	....	....	....	....	....
L	...	...	.....	....	....	....	27.3	32.3	17.6	19.8	61.3	64.5
Ackmen												
9 ....R	...	...	.....	....	....	....	....	31.0	....	21.2	68.4	....
L	...	...	.....	....	....	....	....	31.3	....	21.5	68.7	....
11 ....R	...	...	.....	....	....	....	....	29.4	....	16.9	57.5	....
L	...	...	.....	....	....	....	....	....	....	....	....	....
23 ....R	...	...	.....	....	....	....	....	27.1	....	20.2	74.5	....
L	...	...	.....	65	....	....	....	28.3	....	18.4	65.0	....
26 ....R	...	...	315	66	41.5	31.3	26.8	31.0	16.3	16.6	53.5	60.8
L	320	324	314	67	40.5	32.5	27.1	30.2	17.0	17.3	57.3	62.7
29 ....R	331	335	.....	....	....	....	....	30.3	....	18.2	60.1	....
L	327	334	.....	....	....	....	....	30.2	....	18.2	60.3	....

VIII. SYNTHESIS

Mechanics of Lowry Growth

As previously stated, Lowry Pueblo does not represent a homogeneous unit built all at one time. It was, as nearly as I can estimate, added to and modified six or seven times at least. These modifications relate only to the pueblo proper, that is, the building with all-masonry walls, and not to the Basket Maker, semi-subterranean houses.

I do not know what stimulated these different building activities. I can only guess that they were made necessary either by the natural increase of the population, by the advent of immigrant groups, presumably from the south, or by group fancy. Dr. von Bonin has shown (Chapter VII) that the inhabitants of Lowry were racially very similar to the Pecos Pueblo Indians and that there was no radical change in physical type.

The building sequences given herewith are based on evidence afforded by bonding and abutments (although these factors, as pointed out in Chapter II, are not always trustworthy), by faced and unfaced walls (assuming that the former were exposed and the latter, hidden), by similarities in masonry techniques, by pottery sequences (only to a very limited extent), and by general impressions.

It is difficult to decide whether the nucleus (Rooms 10, 15, 19, and 21) came before the Great Kiva and Room 18 (the original Room 18 and Kiva F stand untied to any other room and unconnected by wall abutments), or conversely. Before I obtained the tree ring dates, supplied by Dr. Emil W. Haury, Gila Pueblo, Globe, Arizona, and by Mr. W. S. Stallings, Jr., Laboratory of Anthropology, Santa Fe, New Mexico, I felt sure that the nucleus was the original unit, because all the walls of the rooms surrounding it abut on the walls of the nucleus—in other words, the walls of the nucleus are continuous, and unbroken (the masonry in all of them is identical and is Chacoan). Now that I have the cutting dates of five logs from Room 21 (of the nucleus) and a date from the logs from the Great Kiva, I am less certain of my former conviction. The evidence is as follows:

The yellow pine logs from the west doorway of Room 10 and from the doorway of Room 15, were squared somewhat—a process which removed the outer rings. Therefore, the cutting date on these logs is unknown. The most that Haury will say is that they

were probably cut some time in the eleventh century of the Christian era. Five of the roof beams from Room 21 yield a cutting date of A.D. 1090 (Stallings).

Eight juniper logs, which once formed part of the roof of the Great Kiva, yield a cutting date of A.D. 1086 (Haury).

No dates were obtained from the original roof of Room 18 (before it was converted to Kiva D), but, judging from the masonry which is peculiarly like that of the Great Kiva and unlike any other masonry in the entire pueblo, Room 18 may have been constructed at the same time as the Great Kiva.

If the dates for Room 21 and the Great Kiva are correct, it follows that the Great Kiva and Room 18(?) were erected before the nucleus (Rooms 10, 15, 19, and 21). It seems probable, then, that there were other rooms clustered about Room 18, since a Great Kiva would probably not have been built or would not have been needed by a group of people few enough in number to crowd into one room (18). If there were other rooms clustered about, all traces of them have disappeared or have not been discovered. Kiva F is tied to Room 18 and was probably built with it.

On the other hand, Room 21 was modified at some later date—witness the secondary walls. It is barely possible, therefore, that the date of A.D. 1090 comes from those logs which were inserted when the later walls were erected. If this date of A.D. 1090 is the date of the *replacements*, it is possible that the nucleus was built at a slightly earlier date, perhaps A.D. 1050.

Since I am not certain which comes first, I have included the nucleus, Room 18, and the Great Kiva in one drawing, which represents an early, if not the earliest, stage in the development of Lowry Pueblo (Fig. 53, *a*).

First Addition.—The first addition, the "x" area, located south of the nucleus (Rooms 10, 15, 19, 21), was probably not connected with it (Fig. 53, *b*). The exact size and extent of this addition are unknown, because some of its walls were torn out by the inhabitants at a later date. The room arrangement was probably not the same as that of the next period. I feel sure that this "x" area contained several secular rooms and later a small kiva (not Kiva B) and a few rooms. This seems so because (1) fragments of demolished cross walls antedating Rooms 3, 7, 17, 26, and 27 were uncovered in this rectangle; (2) part of a curved wall of an earlier kiva and several fragments of its roof lying crib-fashion were observed; (3) the remains of a massive roof were found, a roof which must have

covered a room and which, as shown by the position of its beams, must have spanned the area later occupied by Kiva B.

Two different logs of juniper which served as lintel pieces of the doorway in the east wall of the "x" area (Fig. 53, *b*) yield a cutting date of A.D. 1104, plus or minus one (Stallings). The date for this first addition may then be assumed to be about A.D. 1104. The masonry of the walls of this period is assuredly Chacoan, although the slabs used in building these walls are thinner than those of the nucleus (10, 15, 19, 21). But, without this tree ring date just referred to, I should have found it impossible to decide whether the masonry of the nucleus is older than that of the "x" area or not.

Second Addition.—The building program of this period was ambitious (Fig. 53, *c*). Several rooms and an earlier kiva in the "x" area were demolished to make way for Kiva B (Plate XCIII). The west wall of this same area was torn down and a tier of rooms added (Rooms 4, 5, 6, and 20). One of the walls of Room 4 was bonded to the older, south wall of the "x" area and the walls of Room 20 were abutted on the nucleus.

The north wall of the Kiva B plaza was erected and was tied to an existing wall. Simultaneously, a spur of wall, in which a doorway was placed, was bonded to the parent wall (south wall of Room 8), this spur acting as the east side of Room 8. The west end of Room 8 was already formed by Room 20.

At the same time, Rooms 11, 12 and 14 were probably erected. To assume this seems fair because (1) without Room 11, Room 8 would have been incomplete; (2) the south and east walls of Room 11 were built as a unit as shown on the ground plans; (3) the masonry is similar to that of the west tier (4, 5, 6, 20); (4) the doorways of 11, 12, and 14 are in line with one another, an unusual occurrence at this pueblo; (5) these rooms are alike in shape and size (symptoms of contemporaneity?). These last mentioned rooms certainly came after the nucleus, because their walls abut on it.

Room 7 was also built with Kiva B because (1) the base of the south wall of this room rests on refuse (purposely placed about Kiva B); (2) it was level with the roof of Kiva B—that is, about 6 feet above ground level. Rooms 17, 26, and 27 were likewise probably specially constructed at this time to occupy unused space about Kiva B because the outer surfaces of the north and east walls of Room 26, the outer surfaces of the north and west walls of Room 27 and the outer surface of the south wall of 17 (that is, the wall surfaces

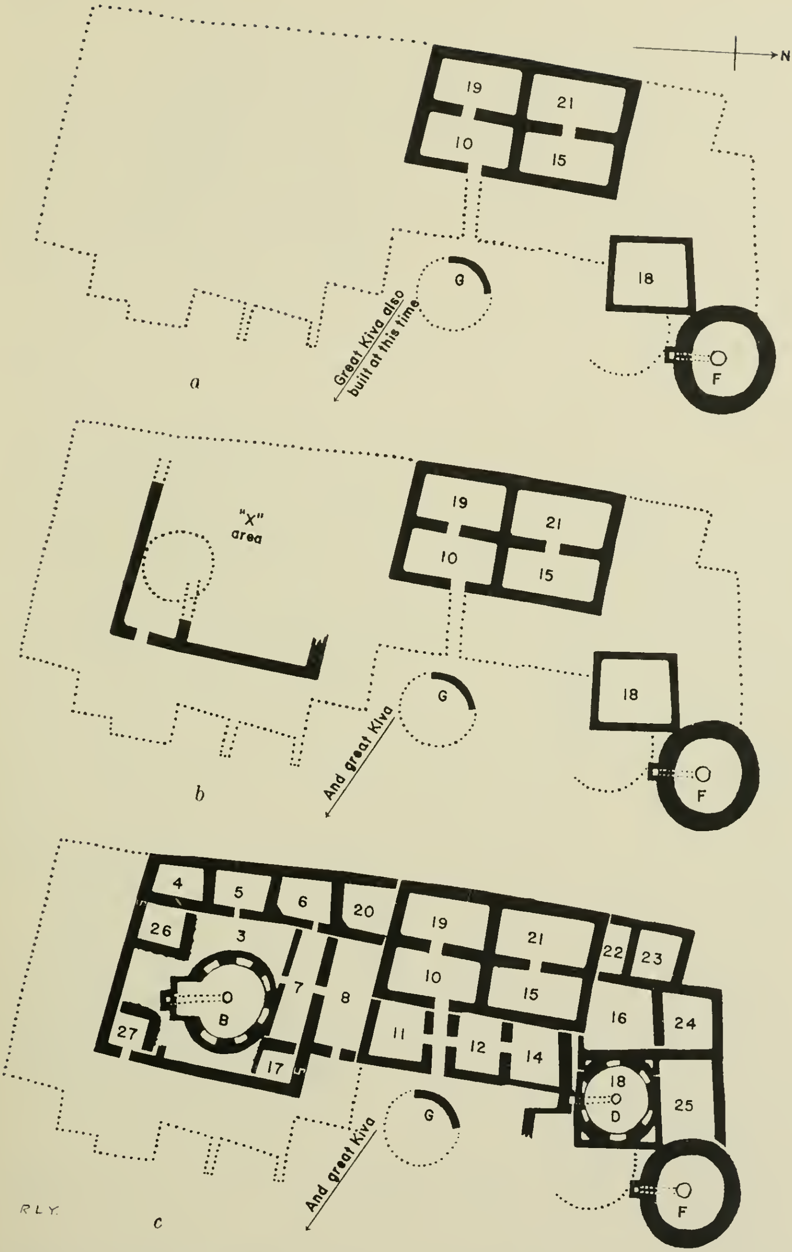


FIG. 53. Plan showing growth of Lowry Pueblo. *a*, Earliest stage; *b*, First addition; *c*, Second addition.

nearest Kiva B) are all unfaced or unfinished. I interpret an unfaced wall as one which was to be concealed, and a faced wall, as one which was to be exposed.

Moreover, as further proof that Rooms 7 and 17 were built with Kiva B, I cite the following evidence: the north and east walls of Room 7 are unfaced below the floor level (which is really at second story height since the floor was level with the roof of Kiva B), and faced above the floor level. In other words, this seems convincing proof that the builders of Kiva B intended to utilize some of this area for rooms—hence, the unfaced walls, which were to be hidden by fill, and the faced walls, which were to be visible.

Likewise, since Kiva D contains inter-pilaster shelves, exactly like those in Kiva B, and since the masonry in both kivas is alike, it is probable that Kiva D was also constructed at this time.

Then, if Kiva D was built during this third period of growth, it is certain that Room 16 was also then erected, because there is no doubt whatsoever that Room 16 and Kiva D were planned and completed together. (When Room 18 was converted into Kiva D, the original west wall for Room 18 was demolished and the north and south walls extended about three feet. Then, the curved wall of the kiva and the east wall of Room 16 were laid up simultaneously, as shown by the fact that the east face of the east wall of Room 16 is composed of large, crude, uncut and unfaced, foundation-like stones below the banquette level of the kiva, and of faced stones above that level. The builders employed rough stones for the lowest courses in this east face, because they realized that such stones would be completely hidden by the well-constructed bench-wall of the kiva. They may have felt that it would have been a waste of time and energy to prepare stones which were not to be exposed.)

A single piece of roof beam (yellow pine) was recovered from Kiva B and one from Room 8. Both these pieces cross-date one with the other and both yield a cutting date of A.D. 1106, which confirms my conclusions deduced from archaeological evidence. But a date obtained from single logs is not sufficient evidence for fixing a period.

Third Addition.—The third addition (Fig. 54, *a*) apparently included Kiva A and several rooms to the east of Kiva A plaza in the space later given over to Rooms 13, 31, 32, and 33. I assume this to be true because (1) the walls for these rooms abut on the walls of earlier rooms; (2) the pottery is similar; (3) the masonry

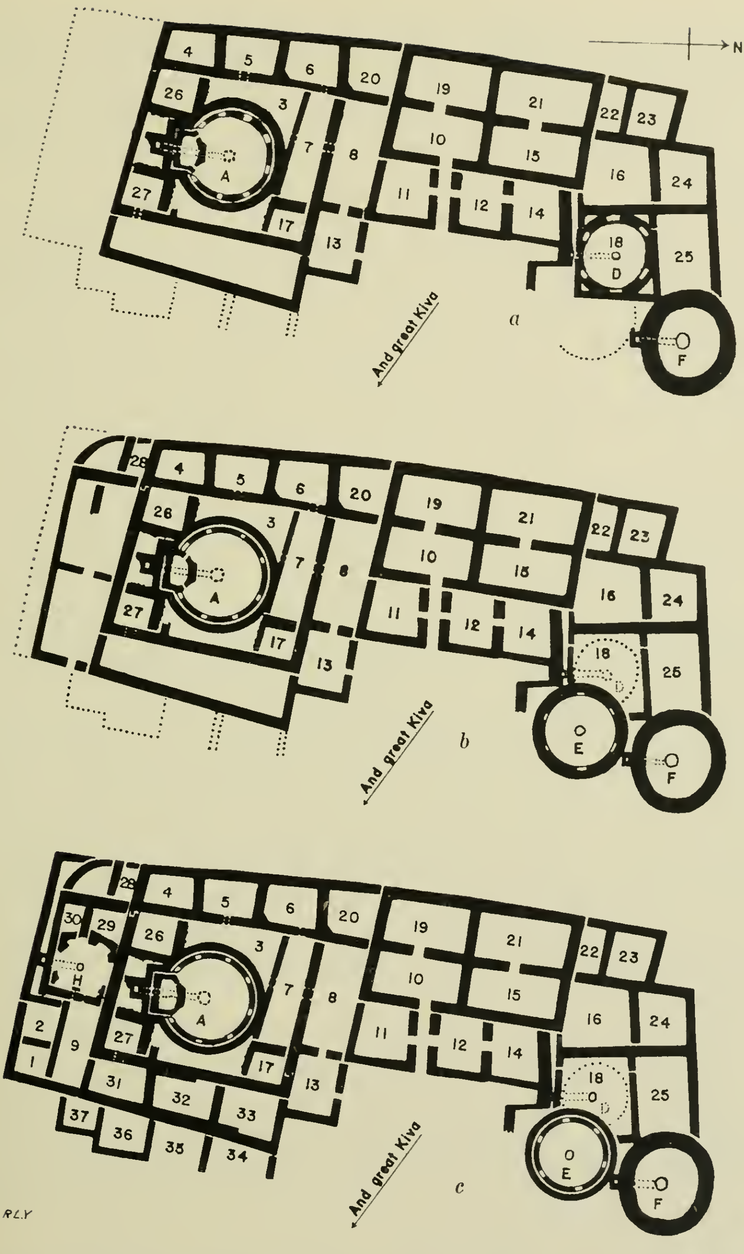


FIG. 54. Plan showing growth of Lowry Pueblo. *a*, Third addition; *b*, Fourth addition; *c*, Fifth addition.

is identical; (4) the walls of the later additions abut on or were built on top of the walls of this third addition. Then, in order to make Kiva A appear subterranean, the doorways in Rooms 5, 6, 7, and 27 were sealed up so that the first and second stories of Rooms 5, 6, and 27 and the second story of Room 7 could be filled with dirt.

Fourth Addition.—The fourth addition (Fig. 54, *b*) consisted of Rooms 28, 29, 30, and several other rooms which occupied the space later given over to parts of Rooms 1, 2, and 9, and to Kiva H. This is probable (1) because the masonry and pottery are alike; (2) because of the abutments; (3) because of the otherwise unexplainable walls, portions of which were encountered under the floors of the later rooms; (4) because of a large doorway in the west wall of what was later Room 9—a doorway which would not have been used for entering a kiva, if a kiva (H) had existed at this time.

Fifth Addition.—The fifth and final major addition (Fig. 54, *c*) witnessed (1) the demolition of earlier walls belonging to the previous period; (2) the construction of Rooms 1, 2, and 9 as they now are; (3) the building of Kiva H and the blocking up of the doorways in Room 9 so that the first story of that room could be filled with dirt in order to make Kiva H appear to be subterranean; (4) the erection of a unit of wall, the main part of which lay just outside and south of Kiva H and Rooms 28, 29, and 30, and a spur of which formed the west wall of Room 2. This wall, just described, created a long, narrow space in which the ventilator shaft for Kiva H was inserted and in which refuse was dumped in order to make Kiva H technically subterranean, although the kiva floor was not actually below the ground level. At the same time that this narrow space was filled with refuse, the first stories of Rooms 9, 29, and 30 were also filled with refuse in order to make Kiva H appear to be below ground.

It seems certain that these additions and changes were the last ones to be made because no other walls abut on them.

Meanwhile, many other alterations took place. At various undetermined dates, secondary walls or partitions and storage bins were thrown up in Rooms 5, 8, 10, 11, 12, 14, 15, 19, 21, and 28.

I do not know when Kivas C and G were constructed. Kiva E naturally came after Kiva D.

Thus, on the basis of the evidence afforded by dendrochronology, it is probable that Lowry Pueblo was constructed over a compara-

tively short period of time. The earliest date is A.D. 1086 (Great Kiva) and the latest date, A.D. 1106—a period of only twenty years. Although no dates are available for many of the later annexes, I believe that they, too, were erected over a short span of time—perhaps twenty-five years. Of course, it must be borne in mind that there were periods during which the entire or almost the entire site was abandoned. But I should guess that a period of one hundred to one hundred and fifty years would easily encompass the history of the entire occupation of the site. Before the tree ring dates were secured, I had considered that the life-history of Lowry would easily span three or four centuries.

The pottery series, as worked out from the refuse areas, likewise bears out this conclusion, for there is little pronounced change in the dominant ware, Mancos black-on-white.

As explained previously, the masonry techniques were Chaco-like, non-Chaco, or Intermediate in type. The Chaco-like characteristics tied together the Great Kiva, the "nucleus," the rectangle about Kiva B, Room 18, and Kiva F as early (Fig. 53, *b*); while the block-like, non-Chaco masonry found across the south end and on the east side was a late addition as shown by wall abutments. However, the two or three Intermediate types contributed nothing to our knowledge of chronological sequence. For example, the masonry of Kiva D and that of Room 16 are dissimilar; yet there is such interlocking that I feel sure that they were erected as a unit. Likewise, the variations in masonry traits of the walls added in Intermediate times (Rooms 4, 5, 6, 8, 11, 12, 14, and 20) did not help work out the chronological sequence. This was a disappointment to me as the trait variations were interesting in themselves.

Moreover, the attempts to obtain room sequences by the study of the sherds were not particularly successful. The periods of building and occupation were too short to allow consistent or undisturbed deposits of sherds at floor levels that would give evidence of this. In the main, the continuity or discontinuity of the walls was the most reliable guide to sequence. Even this evidence gave data containing apparent contradictions until it was studied long and critically, and finally supplemented by the dendrochronological data, which are convincing.

The mechanics of the growth of the pueblo are, therefore, complex. Very often the newcomers or the later inhabitants decided that already existing rooms were too large to suit their tastes or purposes. They therefore divided the old rooms by means of flimsy

partitions. Sometimes, too, instead of cleaning out and utilizing deserted though well-built rooms, these newcomers used parts of these older rooms for storage purposes, as in Rooms 10 and 11, and as places for dumping refuse. At the same time that they were wasting (from my point of view) desirable, well-built quarters, they were erecting more rooms, which were small and poorly built.

There is little evidence for believing that any preconceived building plans existed. It is true that a few rooms were constructed as a unit (the nucleus). But, on the whole, the pueblo grew by jerks and as fancy or chance dictated.

It is apparent, too, that stone-robbing was common, for later walls were partially constructed of stones taken from earlier walls. This custom of using old walls as stone-quarries saved the builders much time, but confuses the archaeologist.

Population

I am unable to estimate exactly the size of the population of Lowry Pueblo. Since only small portions of the pueblo were inhabited at any one time (perhaps only 15 or 18 rooms), it is probable that the population at any given moment during the history of the village was small—consisting perhaps of only fifty or sixty souls. The paucity of skeletons bears out this notion.

Architectural Knowledge

There is no evidence for believing that the architectural knowledge of the builders of the pueblo was profound. Broken joints do occur and more frequently in the older masonry than in the younger; but these joints were probably accidentally broken. The earliest walls, which are the best and the solidest, were erected on foundations; the later ones were not. Sometimes the builders were either careless or ignorant, because some walls were bottomed on ashy refuse or soft fill. Such walls always cracked or slumped and (in ancient times) had to be propped up with posts or by means of extra walls. When a new group of rooms was needed, the new walls were abutted on, or, occasionally, bonded to old ones. All the walls were built with a rubble core and faced on both sides with surfaced stones; header stones were never employed.

The ceilings or roofs were flat and of simple construction. The logs composing them were either socketed or placed on ledges. In one room the main beams rested on stone pillars (Room 16, Plate

XCIV). Wall plates were employed in four instances only. Many of the roofs were inherently weak, due to improper planning; they subsequently had to be supported by props.

MASONRY CLASSIFICATION

For the purposes of this paper, the masonry has been described as "Chaco-like" and "non-Chaco." The term "Chacoan" does not refer to cultural traits transplanted from Chaco Canyon but to generalized cultural traits, which moved up from a southern focus and which were responsible not only for the pueblos in Chaco Canyon, but also for all other pueblos which reflect these southern, Chacoan characteristics. "Chacoan" then is a general term. None of the Lowry-Chaco masonry is as good as the best at Pueblo Bonito, Chetro Ketl or Aztec; but much of it is as good as the better masonry at those sites. The non-Chaco masonry resembles some which exists at Mesa Verde National Park.

But no conclusions can be stated about Lowry or any other masonry nor any comparisons drawn, because practically no information on the essential details of pueblo masonry exists. It is a pity that so many sites have been investigated and that, withal, scarcely any accounts concerning wall construction in all the published reports, exist. I very much hope that the study of masonry technique and classification, right or wrong, as inaugurated herein by Mr. Roys will at least make archaeologists (including myself) realize that they have been cursed with "eyes that see not" and will spur them on to describe systematically all the essentials of wall-building in every pueblo hereafter investigated.

RESULTS OF STRATIGRAPHIC STUDY

The sequence at Lowry of painted wares is: (1) Mancos and Wingate black-on-white; (2) McElmo black-on-white; (3) Mesa Verde black-on-white. The sequence of corrugated pottery is: (1) plain corrugated-neck and indented-neck; (2) indented corrugated (all over). Mancos black-on-white pottery seems to be related to an early, undifferentiated pottery which probably originated to the south.

COMPARISON WITH OTHER RUINS

Some portions of Lowry pueblo are similar to Pueblo Bonito, Chetro Ketl, Aztec, Pipe Shrine House and Yucca House(?); other portions are similar to Far View House, Cliff Palace, Spruce

Tree House, and to Bear Tooth Pueblo (near Lowry). The same comparisons hold true also for the pottery.

CONCLUSIONS

The inhabitants of Lowry Pueblo apparently did not have any dread of attack. The pueblo lies on a mesa and never possessed any defense system. It could easily have been raided and sacked, but such a misfortune seems never to have been visited upon the village. Many rooms have entrances at the ground-level—a sign that invasions were not expected(?).

I have stated previously that evidence exists for believing that the pueblo was deserted and reoccupied several times. I do not know why the site was temporarily forsaken or finally abandoned, but I feel certain that relinquishment was voluntary and leisurely, since no signs of violence, destruction by fire, hurry, or disorder were discovered. The rooms, except number 10, contained nothing but wind-deposited dust and rotten roof timbers or rubbish composed of ashes, potsherds, and animal bones. The last inhabitants took with them all their portable effects. Final desertion probably took place long before the great drought of A.D. 1276–1299.

The relative chronological position of the pueblo may be put at late Pueblo II (Developmental Pueblo Period) and early Pueblo III (Great Pueblo Period). Both pottery and architecture bear out this statement, for Wingate black-on-white at Red Mesa (near Gallup, New Mexico) is dated at about A.D. 950 (Gladwin, 1934) and Chaco masonry in the larger ruins has been dated at Chaco Canyon at A.D. 919 or later (Douglass, 1935).

Dendrochronology makes it possible to give an absolute dating for certain portions of the building—A.D. 1086 to 1106. These dates are helpful, but are not inclusive, for it is possible that the first rooms at Lowry were constructed somewhat before A.D. 1086; and it is probable that the south portion was inhabited for a few years after A.D. 1106. But how much longer is any one's guess—I should say for not more than fifty years. These dates, then, fix Lowry as existing during the last part of the dated period at Pueblo Bonito (A.D. 919–1130) and at Aztec (A.D. 1110–1121) and during the early part of the dated period at Mesa Verde (A.D. 1066–1273).

The presence at this site of Chacoan pottery, masonry, and massive walls can only be explained by postulating that certain cultural elements from the Little Colorado-Puerco focus moved northward, reaching the site under discussion some time in the

eleventh century of our era. These cultural elements may be listed as follows: (1) pottery, including designs, shapes, type of paint, surface finish; (2) two sorts of kivas, one of which is small and is incorporated in the pueblo within a rectangular enclosure; the other sort, the Great Kiva, a class associated, so far as is known, only with some form of Chaco culture; (3) a type of masonry which is composed of long, thin, stone slabs, laid horizontally in well-marked courses and of distinctive spalls; (4) large rooms (10 x 20 feet) with high ceilings (9 feet); and (5) the balanced plan of the nucleus.

Some trade with the people to the west was probably carried on, for a small amount of Kayenta pottery was recovered. But the Kayenta branch contributed little, if anything (of an imperishable nature), to the inhabitants of Lowry, although social, religious, and other traits may have been exchanged.

Mesa Verde black-on-white pottery in large quantities occurred in the top portions of the fill of several rooms. The date of its advent and its source are unknown. It may have been introduced from some of the pueblos at Mesa Verde National Park or it may have been manufactured at Lowry as the result of a general fashion of the region at that period.

Modifications of the pueblo were manifold. In fact, the changes made, the demolitions carried out, and the amount of construction undertaken over a short period of time are amazing.

It would seem as if there must have been some uncommon leaven working or some strong force operating which resulted in frenzied and exuberant outbursts of activity. Wherever we dug, we encountered the fragments of cross-walls and the remains of wall foundations; or we discovered that whole rooms had been demolished or a kiva torn out to make way for new rooms or a new kiva; or we observed that a few rooms were filled solidly with tons of dirt and refuse in order that an adjacent kiva, which was actually built above the ground and incorporated within the pueblo building, might be surrounded by dirt to satisfy orthodoxy. And much of this building activity was compressed into twenty years. I estimate that eight rooms were modified and twenty new rooms and three new kivas were constructed within this short interval—no mean task for a few, primitive people, much of whose time must have been taken up with agricultural and hunting pursuits and ceremonial obligations.

I can find no satisfactory explanation for these manifold changes. An increase in population does not solve the problem, for I feel sure,

as stated before, that there were never more than fifty or sixty individuals living at Lowry at any one time, since the entire building as shown on Map 2 was not occupied at one time.

The modern pueblo cultural pattern provides sets of rules and practices for every social and religious situation to such an extent that violence, excesses, and disruptions are not resorted to. Is it possible that the configuration of the pueblo culture of the eleventh century was similar and that, therefore, this restlessness (as indicated by moving away from and back to the pueblo) and these building exuberances were the physical outlets for the group repressions and inhibitions and that they may be regarded as substitutions for various excesses?

At any rate, masonry, architecture, size of the pueblo, and ideas of kiva construction underwent rapid changes at this site during a short period of time.

More intensive and extensive research must be carried on in this immediate area, especially in briefly occupied sites.

INFERENCES

What inferences concerning cultural evolution for this area may be drawn from the facts ascertained at Lowry Pueblo? It seems to me that several deductions may be set forth.

Lowry Pueblo started as a very small, homogeneous village of a few rooms (the nucleus) and two kivas, a small one and a Great Kiva. This nucleus exhibits certain significant qualities or traits. For example, the walls are continuous (except for doorways), were built at one time, and are of the same thickness throughout; the masonry looks as if it had been built by one person; the corner bondings are distinctive and unduplicated in rooms outside the nucleus; the various roof beams were of the same height in all four rooms; the roof construction was identical in the four rooms; and the doorways in the central or inner walls were placed in exactly the same relative positions and are of the same width. Thus, the nucleus shows a trend towards rigidity, uniformity to a fault, duplication, stereotypy, doing things in a prescribed way. All these elements are characteristic of a homogeneous society—a society which has an answer to or a way out of every problem, which has a prescribed method for doing things, which is rigid and antagonistic to new ideas and strangers, and which is more or less isolated—in short, a folk-society. The nucleus represents some of these crystallized, overt elements indicative of this type of society.

Then, the village was deserted for a time—perhaps ten or twenty years, and later reoccupied by a people possessing a homogeneous culture similar to that of the first settlers.

Then again, relinquishment and reoccupation. But this time, the newcomers introduced some innovations which are reflected in the architecture and the pottery. For the additions at Lowry are the handiwork of a less homogeneous group of people, who seemed to have lost some of their folk-traits, due, perhaps, to contacts with other societies. This shift is reflected in the mixed and degenerate types of masonry, the varying size and shape of the rooms, and the lack of regularity and rigidity in placing and planning sizes of doorways, in setting floor levels, and in laying roofs, no two of which were of the same height or type. In other words, this lack of rigidity and uniformity, as expressed in the nucleus, might be described by ethnologists today as symptoms of a more sophisticated people. This breakdown or change from a simple, folk society to a more complex and sophisticated one is not surprising, for when different cultures meet they often degenerate, until an accommodation or a compromise is worked out. Unfortunately, Lowry Pueblo was inhabited for too short a time to permit this adjustment to take place.

It is clear that Lowry Pueblo became the largest and most imposing village in the Ackmen region and that it was deserted and reoccupied several times. The evidence for these conclusions is unimpeachable. But why was Lowry subjected to this particular treatment, whereas the other near-by pueblos, in which I have excavated, were erected, lived in but once and for a very short time, and then forever and finally abandoned? Nor do these other near-by pueblos evince any signs of additions, modifications, annexes, or alterations of any sort.

This site was attractive or alluring for any one of several possible causes. For example, the view of the surrounding country is excellent, and this fact may have appealed to the builders; or proximity to fertile fields and a plentiful water supply may have been an important factor in inducing people to live here. But to my mind, the explanation of the attractiveness of this place may be found rather in the fact that this site enjoyed a Great Kiva, the only one in the immediate vicinity. In other words, Lowry Pueblo may have been a religious center, to which many neighboring peoples repaired to participate in or to watch such ceremonies as were performed in this "cathedral" of kivas. The kiva is a very important factor in the

ceremonial and religious life of modern southwestern pueblo tribes and there is every reason for believing that kivas were just as important to the ancient pueblo tribes as to the modern ones. A Great Kiva seems to represent the summation of all kiva virtues and was probably as much more important than a small kiva, as its size and greatness would indicate. In other words, a village possessing a Great Kiva would undoubtedly be a very important and holy place.

Moreover, the following evidence is further proof for believing that the Great Kiva was the lodestone which attracted peoples from the surrounding country and which set into motion cycles of occupation and desertion:

When the Great Kiva was excavated, I observed that it was of a more primitive type than the one at Aztec or the one at Pueblo Bonito. I therefore expected to find only early pottery. To my surprise, I found, rather, all types of pottery—from early to late—on the floor or buried between the floors which had been reconditioned from time to time. This pottery all came from under the burned remains of the roof. The Great Kiva was never used as a dumping place for no refuse was found within its walls. Therefore, it seems certain that although this structure was built in the very first days of the village, it was used from that time right down to the last. This evidence seems convincing proof that the Great Kiva was the "drawing card" which caused people to settle again and again at this site. This unit, then, was the only one used during all periods. As suggested in my conclusions, the several withdrawals might have been the physical outlets for group repressions and inhibitions.

This village, then, was a common meeting spot where cultural ideas were interchanged, where a stem of the Chaco branch, the roots of which lay far to the south, met and mingled with an indigenous culture, a stem of the Mesa Verde branch.

Such assemblages or encounters as I envisage would naturally produce many repercussions, the effects of which one might hope to find. Such evidence of conflicts is found in the architecture, in the masonry, and possibly in the pottery. The masonry of the nucleus is Chaco-like and is easily distinguishable from other Lowry types. In some of the other rooms, the masonry partakes of both Chacoan and Mesa Verde characteristics, a partial degeneration of a well-fixed masonry-pattern.

Another inference which may be made at this time and to which casual reference was previously made, is that small pueblos of the "unit-type" were probably inhabited by a simple, conservative,

homogeneous group of people—members of a folk society(?)—a society which did not welcome new ideas.

I also conjecture that these small, unit-type pueblos were occupied each in entirety and then abandoned after a very short time and that the people of these small pueblos were living literally amidst the ruins of their fathers' houses.

And conversely, I feel convinced that the large pueblcs were cultural foci where cultural ideas were interchanged and where disintegration and reintegration of folk-ways took place at a rapid rate. It is also extremely likely that these large buildings, such as Cliff Palace, were not entirely occupied at any one time, but that simultaneously, some rooms may have been lived in while others were abandoned and used as rubbish bins.

LOCATION OF PRINCIPAL SITES MENTIONED

Aztec; San Juan County, northwestern New Mexico.
Cliff Palace; Mesa Verde National Park.
Far View House; Mesa Verde National Park.
Kayenta district; Navajo County, northeastern Arizona.
Mesa Verde National Park; Montezuma County, southwestern Colorado.
Pecos; San Miguel County, north-central New Mexico.
Pueblo Bonito; Chaco Canyon, McKinley County, western New Mexico.
Rcd Mesa district; McKinley County, western New Mexico.

BIBLIOGRAPHY

Abbreviations.

AA	American Anthropologist
AE	Annals of Eugenics
AJA	American Journal of Archaeology
AJPA	American Journal of Physical Anthropology
AMNH-AP	American Museum of Natural History, Anthropological Papers
B	Biometrika
BAE-B	Bureau of American Ethnology, Bulletins
BAE-R	Bureau of American Ethnology, Annual Reports
BMSAP	Bulletin et mémoires de la Société d'Anthropologie de Paris
CGS-B	Colorado Geological Survey, Bulletins
HB	Human Biology
ICA	International Congress of Americanists, Proceedings
JANS	Journal of the Academy of Natural Sciences, Philadelphia
JCN	Journal of Comparative Neurology
MMFUT	Mitteilungen medizinischen Fakultät, University of Tokyo
MNA	Museum of Northern Arizona, Flagstaff, Arizona
MP	Medallion Papers, Gila Pueblo, Globe, Arizona
MSAP	Mémoires de la Société d'Anthropologie de Paris
NAF	North American Fauna, published by Bureau of Biological Survey, United States Department of Agriculture
NGS	National Geographic Society of Washington, D.C.
PM-P	Peabody Museum of American Archaeology and Ethnology, Harvard University Papers
PS	Palaeontologia Sinica
PTRSL	Philosophical Transactions, Royal Society of London
PZ	Praehistorische Zeitschrift
USGGST	United States Geological and Geographical Survey of the Territories
ZMA	Zeitschrift für Morphologie und Anthropologie

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INDEX

VIEW TO SOUTH FROM LOWRY RUIN
Ute or El Late Mountains in background

SOUTH END OF LOWRY RUIN

Before excavation

EAST SIDE OF LOWRY RUIN

Before excavation

WEST SIDE OF LOWRY RUIN

Before excavation

GREAT KIVA, LOWRY PUEBLO, BEFORE EXCAVATION

Looking west

NORTH TRENCH, LOWRY PUEBLO
Looking southwest

SOUTH TRENCH, LOWRY PUEBLO
Looking northwest

MINE DUMP-CAR AND CHUTE AT SOUTH END OF LOWRY RUIN

SHOWING METHOD OF CARING FOR DEBRIS EXCAVATED FROM LOWRY PUEBLO

PHOTOGRAPHIC TOWER, LOWRY PUEBLO

Tower 35 feet high; base 8 feet high

ROOM 10, SOUTH HALF, LOWRY PUEBLO

ROOMS 1 AND 2, LOWRY PUEBLO

Looking north

LOWRY PUEBLO; KIVA A IN FOREGROUND
Looking north

LOWRY PUEBLO; ROOMS 14 AND 15 IN FOREGROUND
Looking south

ROOM 19, LOWRY PUEBLO
Looking east

LOWRY PUEBLO; KIVA D (ROOM 18) IN FOREGROUND

Looking southwest

LOWRY PUEBLO; UPPER PART OF ROOM 17 IN FOREGROUND
Looking northwest

ROOM 21, LOWRY PUEBLO
Looking east

ROOM 27, LOWRY PUEBLO
Looking southwest

LOWRY PUEBLO

Looking west from tower, south edge of Great Kiva. Prior to excavations in Rooms 31–37

LOWRY PUEBLO

Looking west from tower, south edge of Great Kiva. After excavations in Rooms 31–37

CHACO-LIKE MASONRY; ROOM 15, LOWRY PUEBLO
Height of section shown, 4½ feet

CHACO-LIKE MASONRY; WEST WALL, ROOM 32, LOWRY PUEBLO

CHACO-LIKE MASONRY; SOUTH WALL, ROOM 18, LOWRY PUEBLO

Three-foot square outlined in chalk

CHACO-LIKE MASONRY; KIVA B, LOWRY PUEBLO
Distance between chalk marks, 3 feet

CHACO-LIKE MASONRY; WEST WALL, ROOM 32, LOWRY PUEBLO

Distance between stadia rods, 3 feet

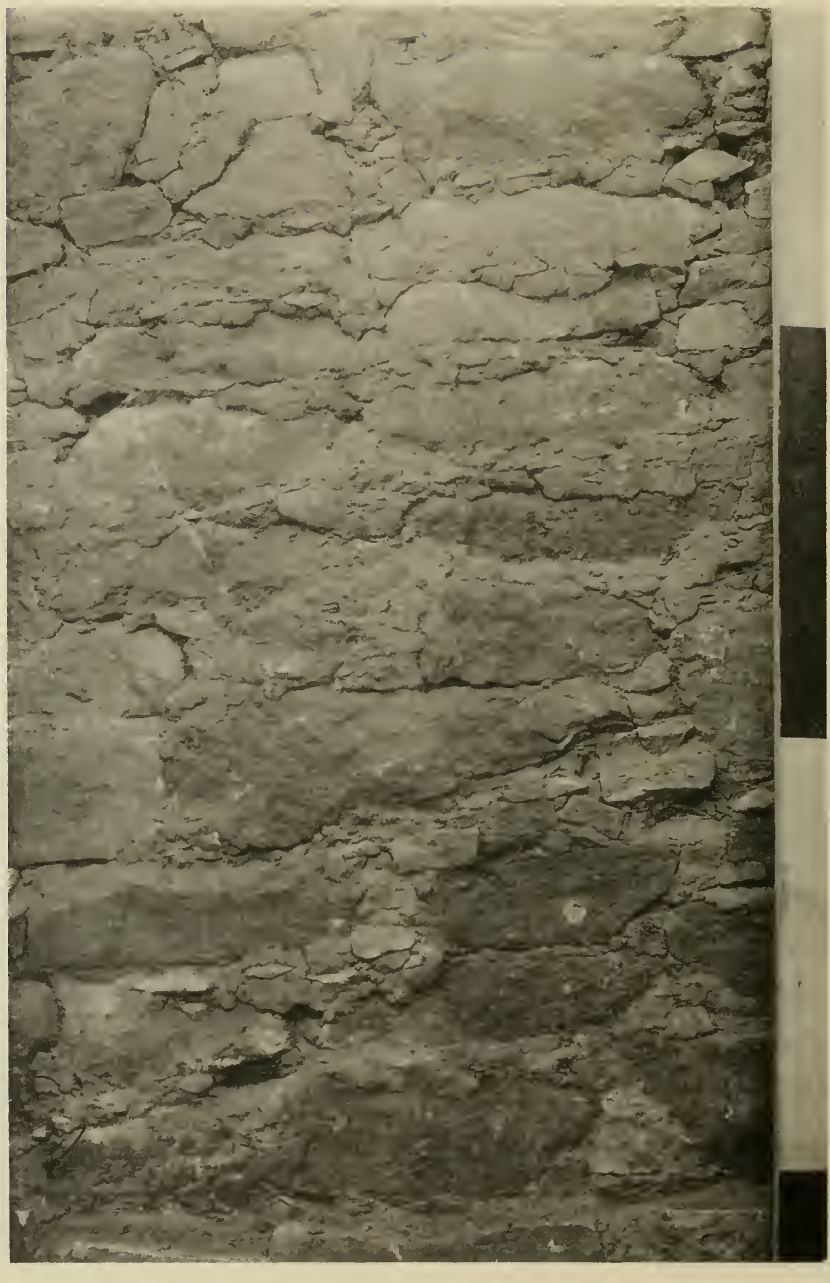
NON-CHACO OR BLOCK-LIKE TYPE OF MASONRY; EAST WALL, ROOM 1
LOWRY PUEBLO

Height of section shown, 3¾ feet

NON-CHACO OR BLOCK-LIKE TYPE OF MASONRY; SOUTH WALL, ROOM 9
LOWRY PUEBLO

Distance between chalk marks, 3 feet

INTERMEDIATE TYPE OF MASONRY; SOUTH WALL, ROOM 12, LOWRY PUEBLO
Distance between chalk marks, 3 feet



INTERMEDIATE TYPE OF MASONRY; SOUTH WALL, ROOM 31, LOWRY PUEBLO
Divisions on stadia rod, 1 foot each

INTERMEDIATE TYPE OF MASONRY; EAST WALL, ROOM 4, LOWRY PUEBLO
Distance between chalk marks, 3 feet

T-DOORWAY; WEST WALL, ROOM 9, LOWRY PUEBLO
Overall height, 7 feet

RECTANGULAR DOORWAY; EAST WALL, ROOM 8, LOWRY PUEBLO
Overall height, 5 feet 2 inches

RECTANGULAR DOORWAY; WEST WALL, ROOM 15, LOWRY PUEBLO
Overall height, 3 feet 5 inches

DIAGONAL BONDING; SOUTHEAST CORNER, ROOM 20, LOWRY PUEBLO

LOOKING WEST INTO SPACE BETWEEN ROOMS 14 AND 16, LOWRY PUEBLO
Showing circular opening in background where wall plate was inserted in north wall, Room 15

SEMI-CIRCULAR BIN; ROOM 11, LOWRY PUEBLO

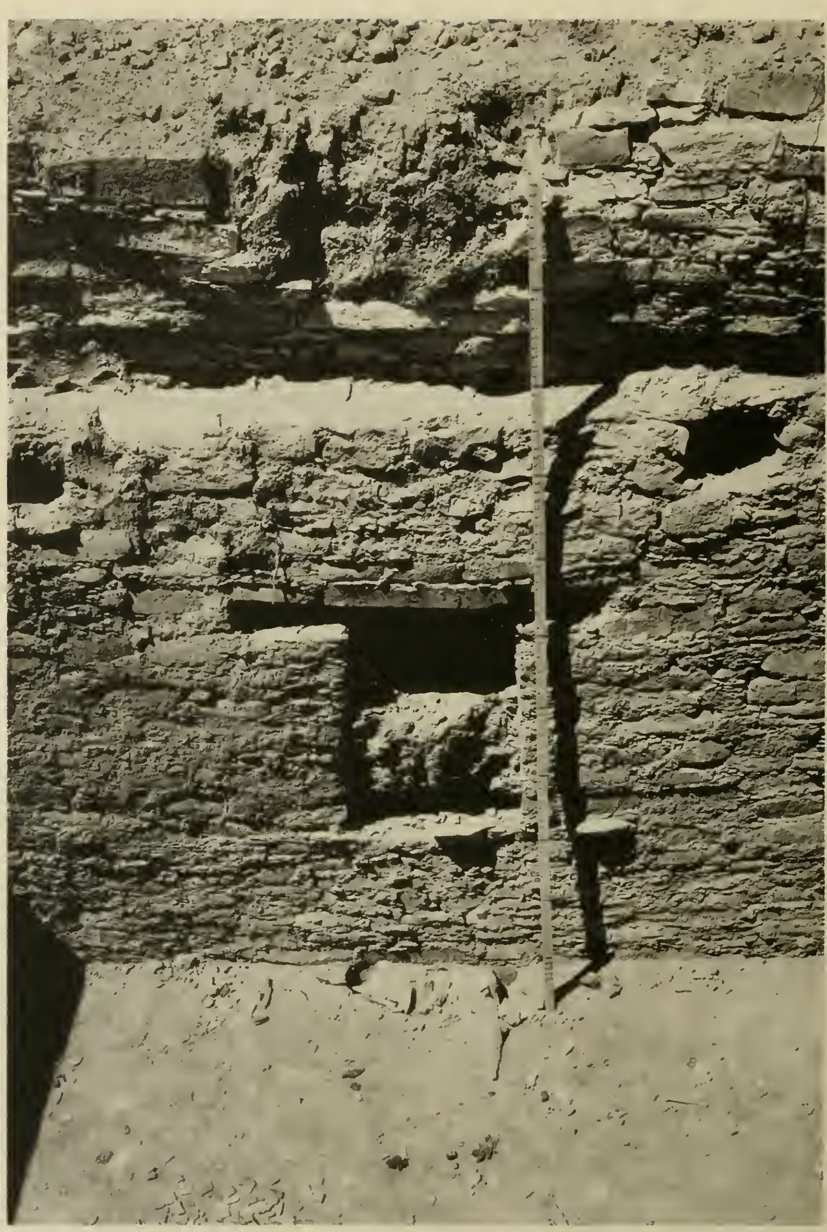
ENTRANCE AND PORTION OF BIN; ROOM 10, LOWRY PUEBLO
Looking south

FIREPIT (FOREGROUND) AND SECONDARY ROOF SUPPORT (BACKGROUND)
ROOM 13, LOWRY PUEBLO

Looking west

FIREPIT "A"; ROOM 35, LOWRY PUEBLO

FIREPIT "B"; ROOM 35, LOWRY PUEBLO



WEST WALL, ROOM 15; SHOWING SOCKETS FOR MAIN ROOF BEAMS AND LEDGE ON WHICH RESTED TERTIARY BEAMS

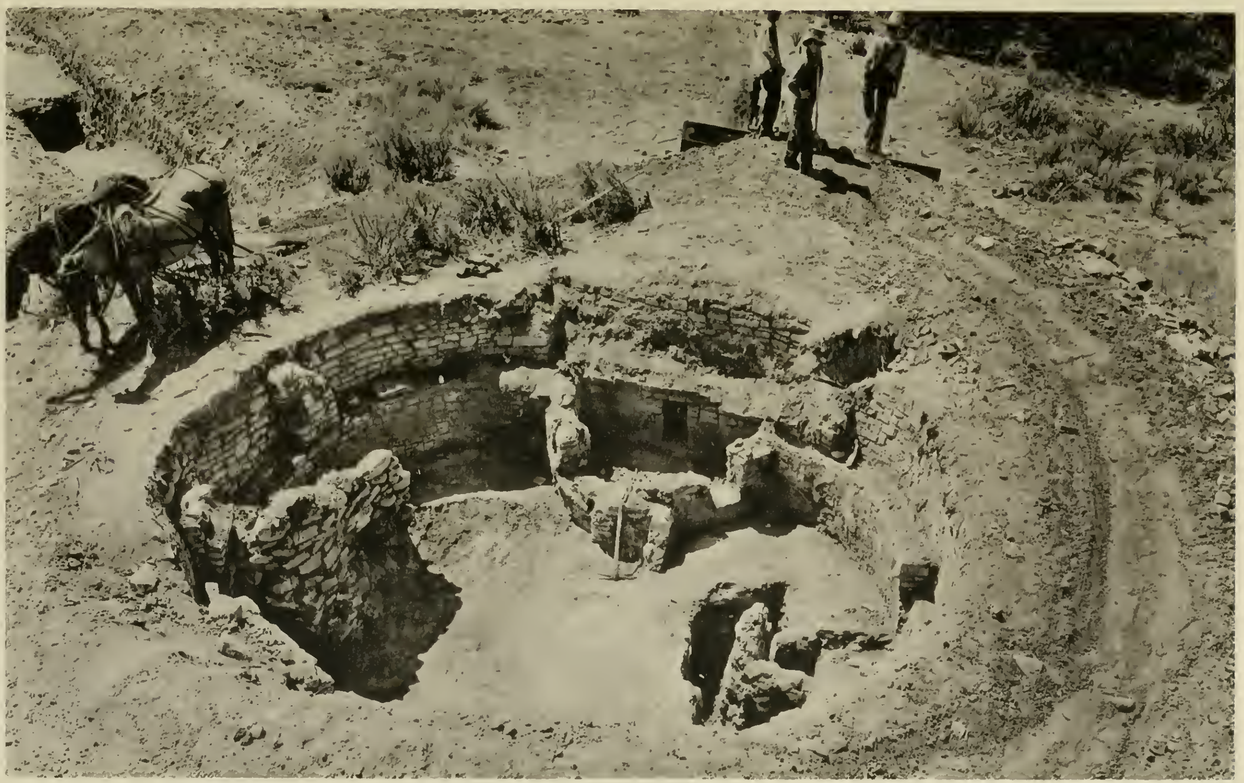
ROOM 27; REMAINS OF MAIN, SECONDARY, AND TERTIARY ROOF BEAMS

NORTH WALL, ROOM 18 (KIVA D), LOWRY PUEBLO; SHOWING METHOD OF ENLARGING ROOM BY EXTENDING WALL

Gap between new and old walls (center) was only fortuitously discovered, so cleverly was it chinked up with mud mortar and spalls

SEALED T-DOORWAY BETWEEN KIVA H AND ROOM 9, LOWRY PUEBLO
In foreground kiva pilaster which is part of seal

SECONDARY WALL, EAST FACE; ROOM 14, LOWRY PUEBLO



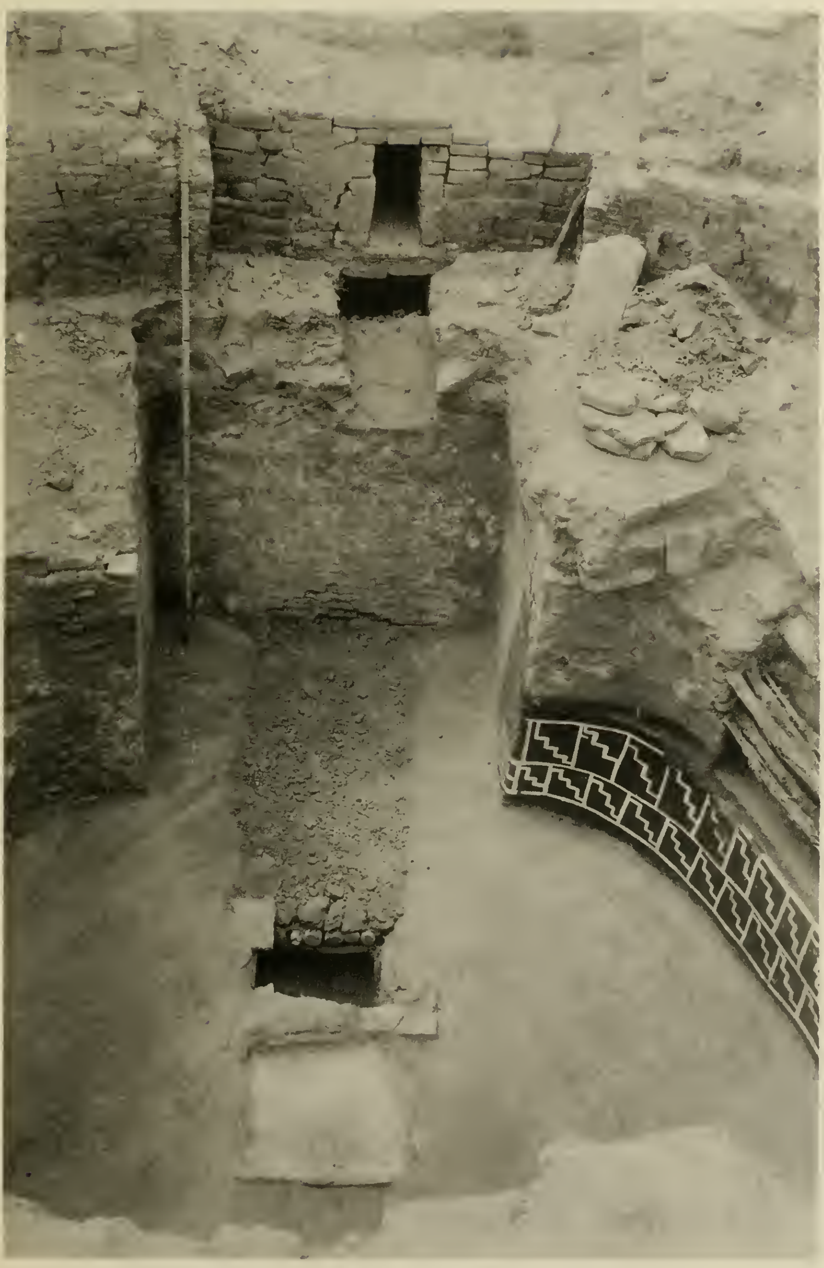
KIVA A, LOWRY PUEBLO

Looking south. In foreground are bins built after kiva was abandoned

LOOKING NORTH THROUGH KIVA A INTO KIVA B, LOWRY PUEBLO

KIVA H, LOWRY PUEBLO
Looking north. Diameter, 11 feet

VENTILATOR SHAFT; KIVA H, LOWRY PUEBLO



KIVAS A AND B, LOWRY PUEBLO; LOOKING SOUTH

Lateral ventilator openings for Kiva A in background; sub-floor ventilator opening for Kiva B in foreground

MASONRY, KIVA C, LOWRY PUEBLO

Distance between chalk marks, 3 feet

MASONRY, KIVA D, LOWRY PUEBLO

Two-foot square outlined in chalk

MASONRY, KIVA F, LOWRY PUEBLO
Distance between chalk marks, 3 feet

MASONRY, KIVA G, LOWRY PUEBLO

Three-foot square outlined in chalk

KIVA F, LOWRY PUEBLO

Holes in floor around circumference once held roof posts

KIVA C, LOWRY PUEBLO
Sub-floor vault, west side of firepit

LOOKING SOUTHWEST INTO KIVA B, LOWRY PUEBLO

Showing sub-floor ventilator, firepit, southern recess, and inter-pilaster shelves

INTER-PILASTER SHELVES; SOUTHWEST QUADRANT, KIVA B, LOWRY PUEBLO

Distance between pilasters, 4 feet

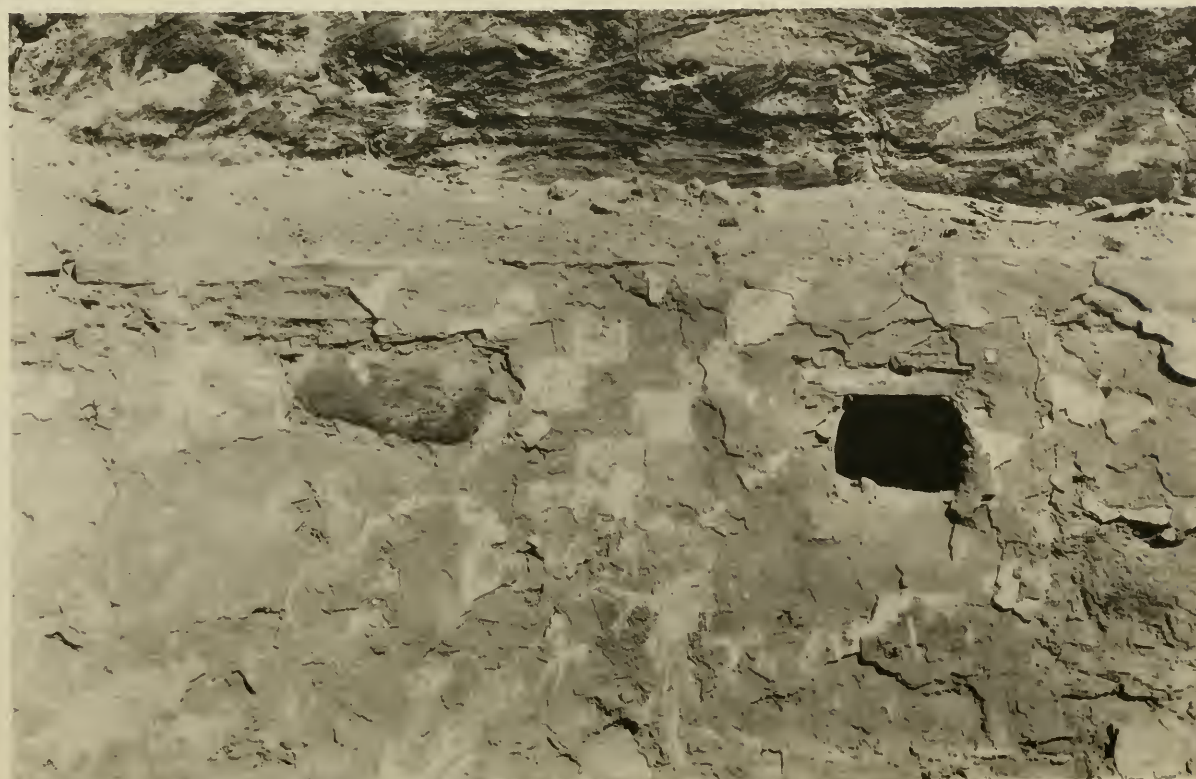
PAINTED DESIGN ON BANQUETTE; SOUTHWEST QUADRANT, KIVA A, LOWRY PUEBLO
This decoration was underneath that shown in Plate LXI

PAINTED DESIGN ON BANQUETTE AND RECESS FOR POST; NORTHWEST QUADRANT, KIVA A, LOWRY PUEBLO

PAINTED DESIGN ON BANQUETTE AND NICHE; SOUTHWEST QUADRANT, KIVA B, LOWRY PUEBLO

Width of niche, 5 inches

PAINTED DESIGN ON BANQUETTE AND INTER-PILASTER SHELVES; NORTHWEST QUADRANT, KIVA D, LOWRY PUEBLO



PAINTED DESIGN ON BANQUETTE; NORTHWEST QUADRANT, KIVA D, LOWRY PUEBLO

This decoration was underneath that shown in Plate LXIII. Width of niche, 6 inches

GREAT KIVA, LOWRY PUEBLO

Looking north. View taken from 50-foot elevation (see Plate X)

SOUTHWEST QUADRANT, GREAT KIVA, LOWRY PUEBLO

Showing west terrace, bench, and southwest pillar base

NORTHWEST QUADRANT, GREAT KIVA, LOWRY PUEBLO

Showing peg(?) or beam(?) sockets and northwest pillar base

SOUTHWEST QUADRANT, GREAT KIVA, LOWRY PUEBLO

Showing west vault

SOUTHWEST QUADRANT, GREAT KIVA, LOWRY PUEBLO

Showing niches

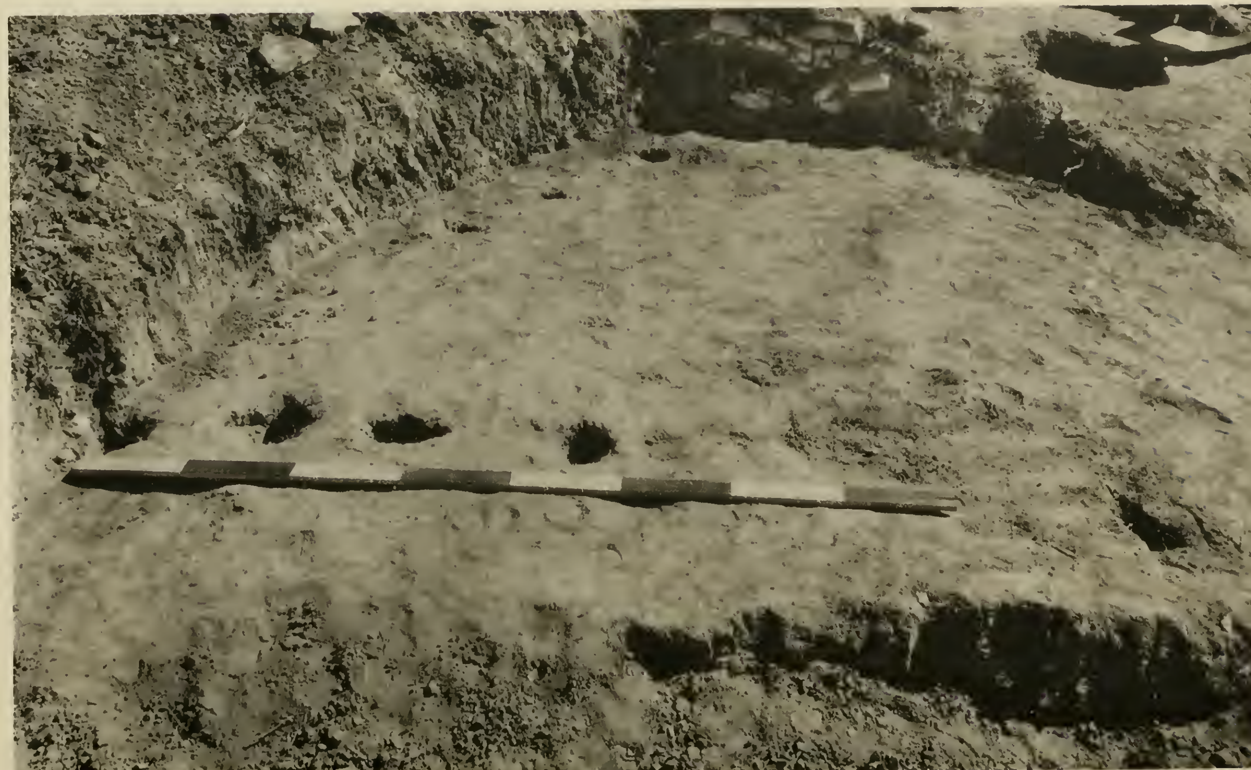
GREAT KIVA, LOWRY PUEBLO

Looking north at recess which had contained stairway. Length of trowel, 9 inches

GREAT KIVA, LOWRY PUEBLO
Looking north at recess, with stairway restored

GREAT KIVA, LOWRY PUEBLO
Looking north at peripheral Rooms I–IV

NORTH WALL, PERIPHERAL ROOM III, GREAT KIVA, LOWRY PUEBLO



GREAT KIVA, LOWRY PUEBLO

Looking east at post-holes in peripheral Room IV

METATE AND MANO; TROUGH OF METATE OPEN AT BOTH ENDS
Length, 1 foot 4 inches. Found on floor of Kiva F

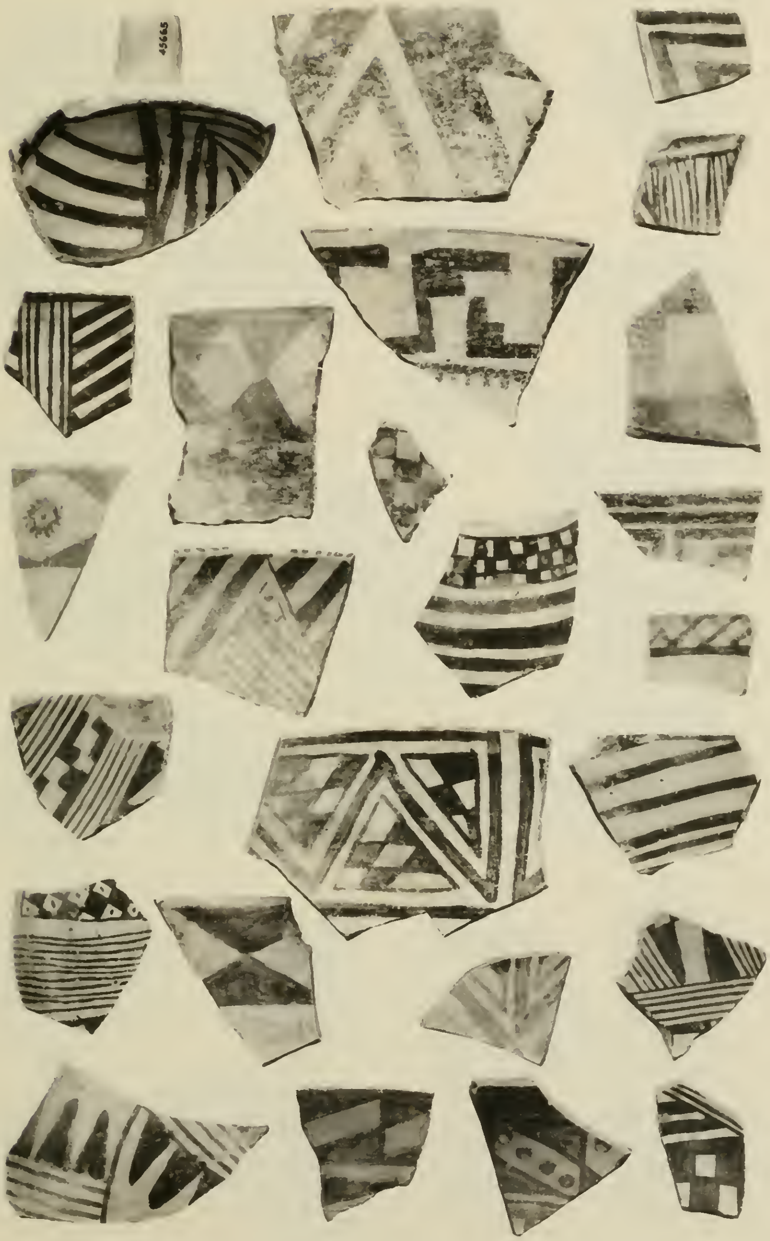
METATE AND MANO; TROUGH OF METATE OPEN AT ONE END ONLY
Length, 1 foot 8 inches. Found in Basket Maker III(?) house, under floor, Room 11

1 2 3

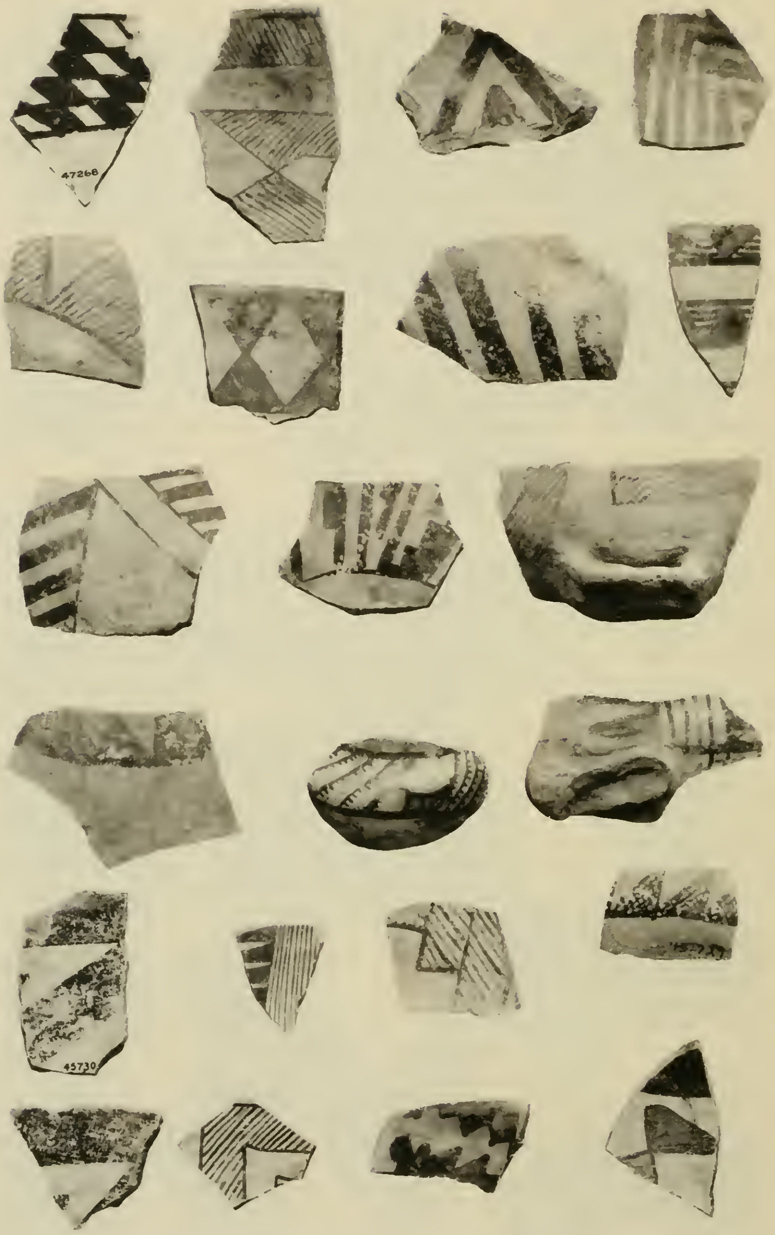
MANCOS BLACK-ON-WHITE WARE

Figs. 1, 3. Bowls from floor, Room 16. Fig. 2. Upper portion of jar, from floor, Room 15. Diameter of Fig. 1, 11 inches

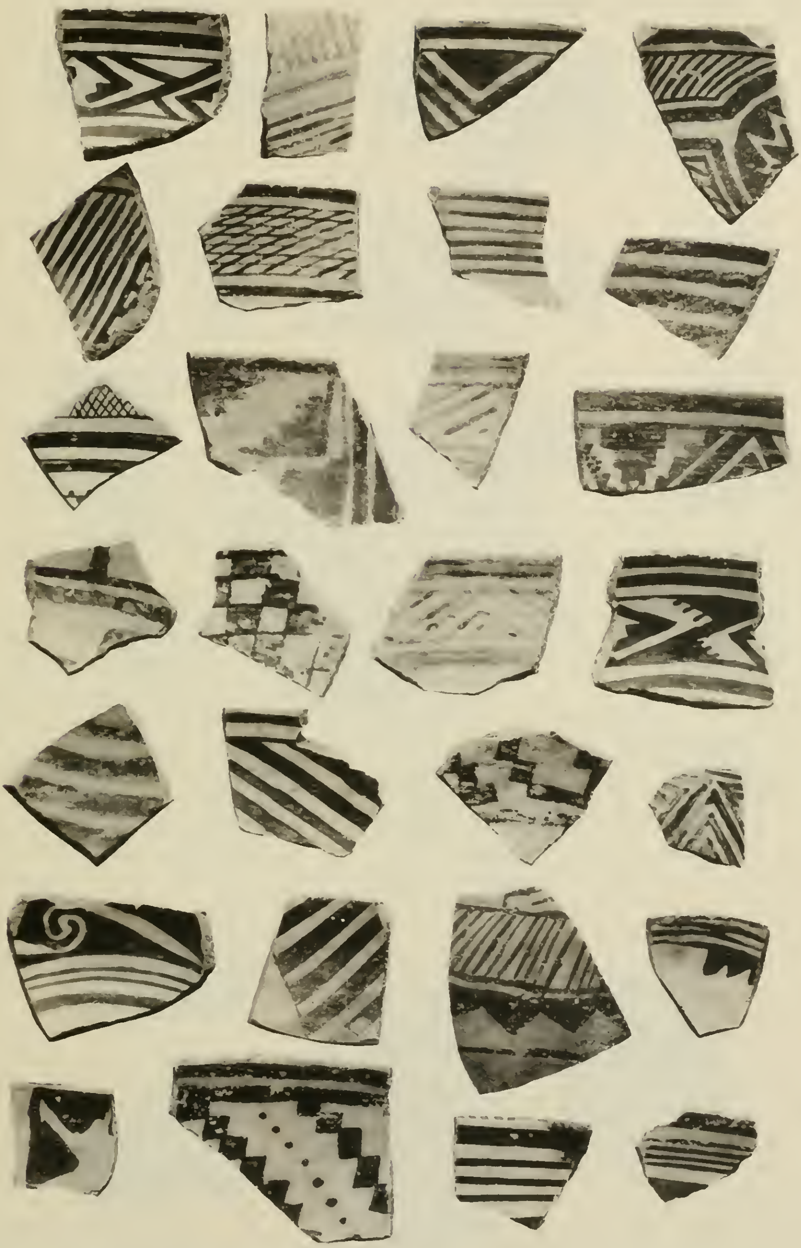
POTSHERDS FROM UPPERMOST CUT (CUT 1); ROOM 8, LOWRY PUEBLO



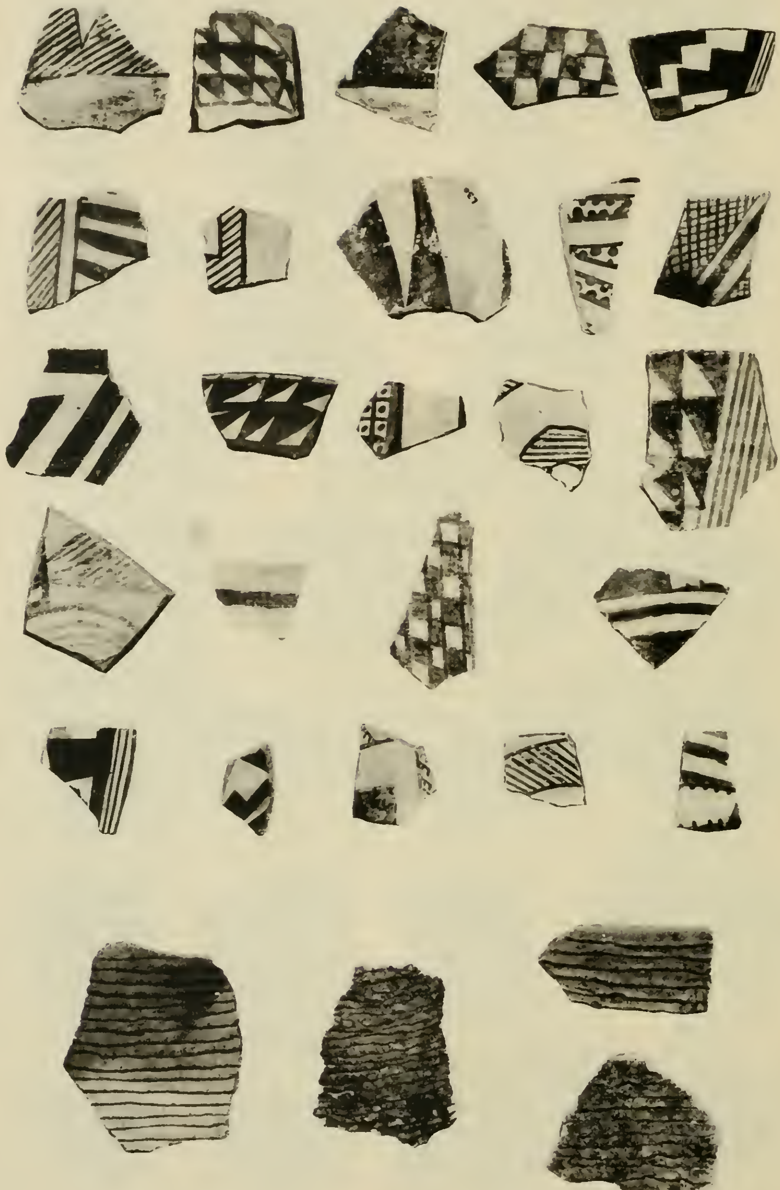
POTSHERDS FROM CUT 4; ROOM 8, LOWRY PUEBLO



POTSHERDS FROM CUT 6; ROOM 8, LOWRY PUEBLO



POTSHERDS FROM UPPERMOST CUT (CUT 1); REFUSE AREA WEST OF ROOMS 4 AND 28
LOWRY PUEBLO



POTSHERDS FROM CUT 4; REFUSE AREA WEST OF ROOMS 4 AND 28
LOWRY PUEBLO

1

2

MANCOS BLACK-ON-WHITE LADLES
Diameter of Fig. 1, 4 inches

PORTION OF LINO GRAY WARE JAR

Found in remains of Basket Maker III house, just east of Room 10. Height, 17½ inches

MALE ULNA AND HUMERI

MALE AND FEMALE FEMORA

MALE AND FEMALE TIBIAE

PATHOLOGICAL LONG BONES

Showing post-mortem deformation of fibula; healed fractures of radius and ulna; abscess of distal epiphysis of femur

MALE SKULL

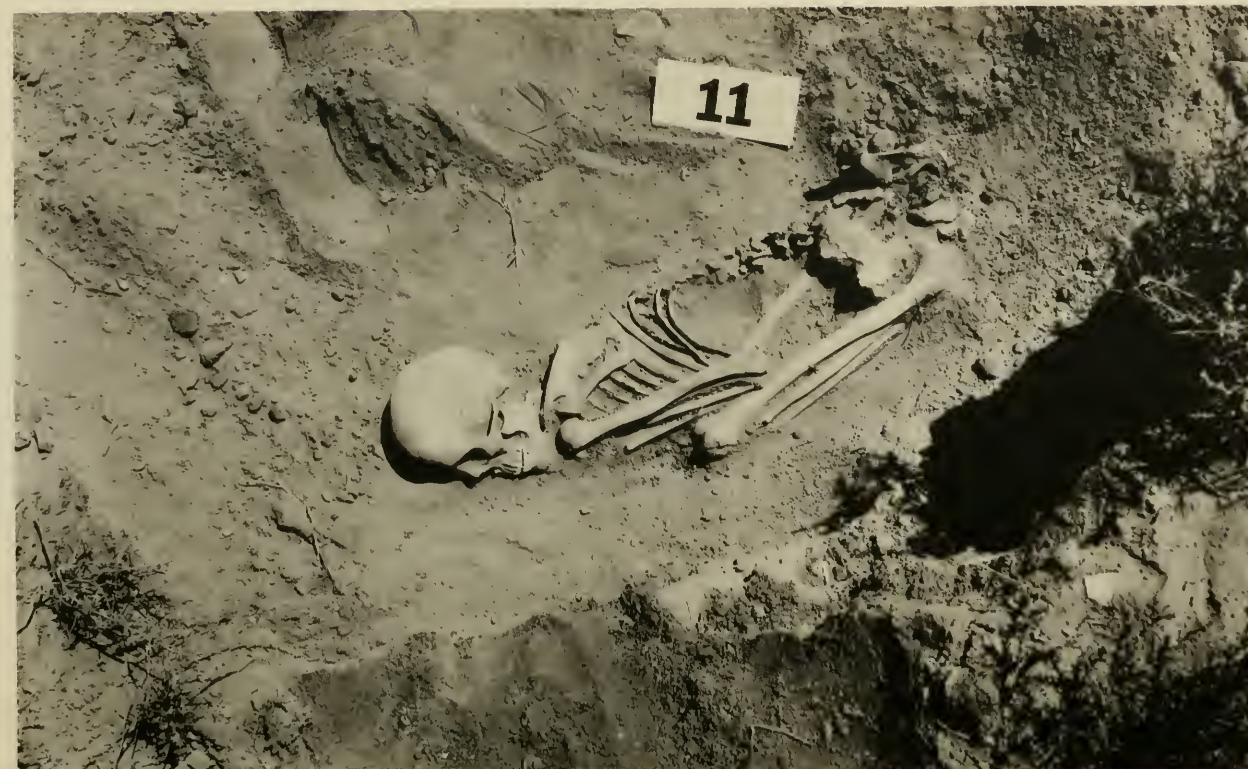
Norma frontalis, Norma lateralis, and Norma verticalis with skull oriented in Frankfurt horizontal

FEMALE SKULL

Norma frontalis, Norma lateralis, and Norma verticalis with skull oriented in Frankfurt horizontal

EXTENDED BURIAL

From small refuse mound, southeast of Great Kiva, Lowry Pueblo



FLEXED BURIAL

From small refuse mound, east of Great Kiva, Lowry Pueblo

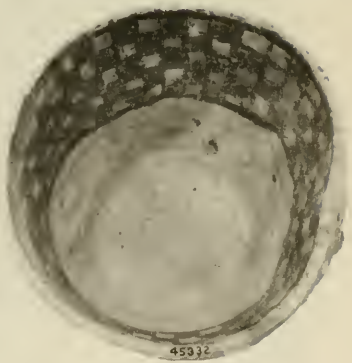
PORTION OF DEMOLISHED WALL (right edge of plate), "X" AREA, LOWRY PUEBLO

ROOM 16, LOWRY PUEBLO

Looking north. Abutment of two types of masonry may be seen in left background; in center, remains of bases of two roof pillars

1

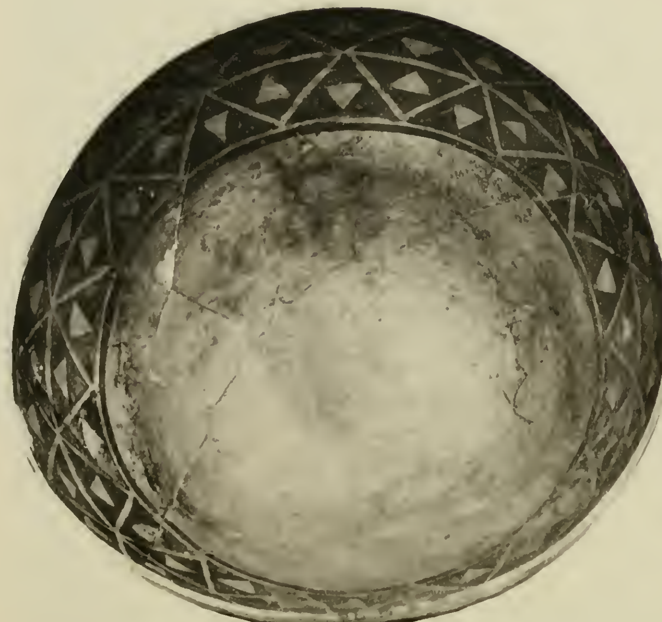
2



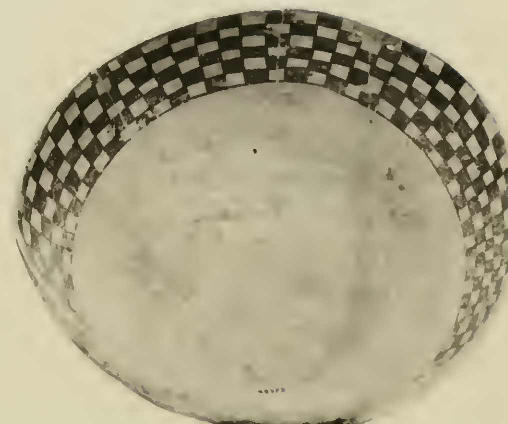
3

MANCOS BLACK-ON-WHITE LADLES

Found on floor, Room 10. Diameter of Fig. 1, 4½ inches



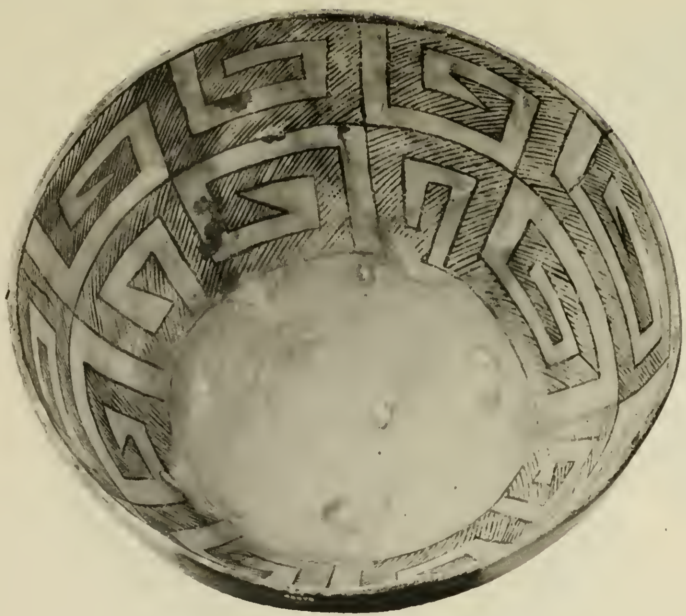
1



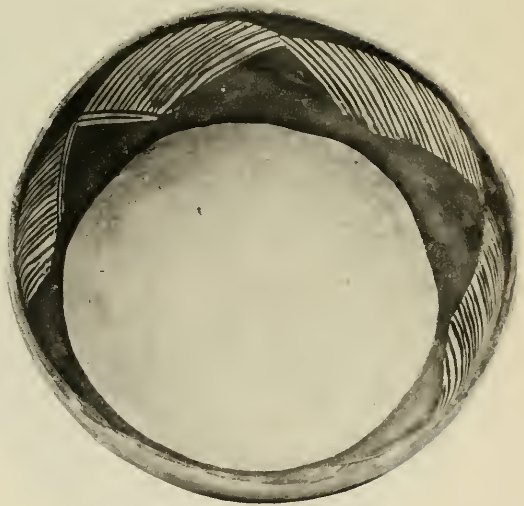
2

BLACK-ON-WHITE BOWLS

Fig. 1. McElmo black-on-white. Diameter, 12 inches. Fig. 2. Mancos black-on-white. Found on floor, Room 10



1



2

BLACK-ON-WHITE BOWLS

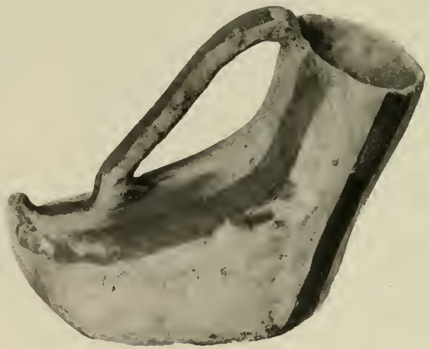
Fig. 1. Chaco black-on-white. Diameter, 11½ inches. From floor, Kiva C. Fig. 2. Red Mesa(?) black-on-white. From burial in refuse area west of Room 28

1

2

BLACK-ON-WHITE BOWLS

Fig. 1. Red Mesa(?) black-on-white. Diameter, 8 inches. From floor, Kiva F. Fig. 2. Puerco(?) black-on-white. From floor, Kiva F



1

2

BLACK-ON-WHITE POTTERY

Fig. 1. Chacoan(?) type effigy jar. From burial east of Great Kiva. Fig. 2. Red Mesa(?) black-on-white seed jar (similar to Plate 13b, Roberts, 1931). Diameter of orifice, 4 inches. From burial in refuse area west of Room 28

1

2

BLACK-ON-WHITE POTTERY

Fig. 1. McElmo black-on-white mug. Height, 4½ inches. From passageway to Room 10. Fig. 2. Mancos black-on-white pitcher. From passageway to Room 10

1

2

McELMO BLACK-ON-WHITE MUGS
From floor, Room 10. Height of Fig. 1, 4¼ inches

1

2

McELMO BLACK-ON-WHITE MUGS

Fig. 1. Height, 3¼ inches. From burial east of Great Kiva (mug has double bottom with space between containing clay pellets).
Fig. 2. From late bin, Room 10

1

2

McELMO BLACK-ON-WHITE BOWLS

From upper portion of (second story?) fill, Room 10. Diameter of Fig. 1, 10 inches

1

2

McELMO BLACK-ON-WHITE BOWLS

From upper portion of (second story?) fill, Room 10. Diameter of Fig. 1, 9½ inches

McELMO BLACK-ON-WHITE BOWL
From passageway leading to Room 10. Diameter, 5 inches

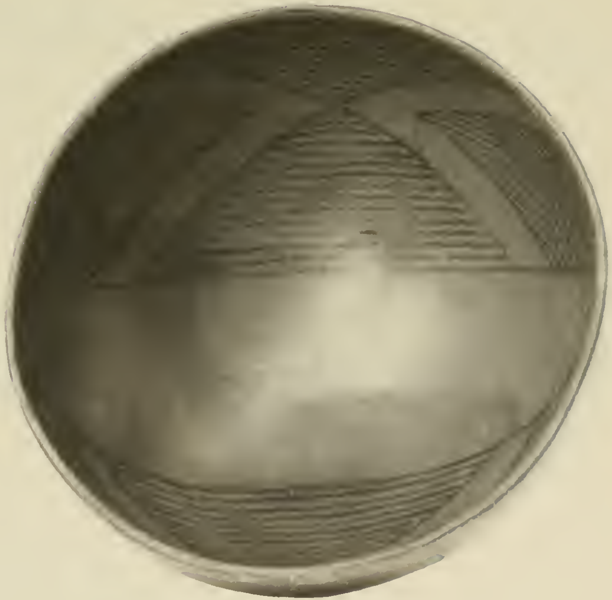
1

2

KANA-A BLACK-ON-WHITE WARE

From burial in refuse area, west of Room 28. Diameter of bowl, 8¼ inches

1



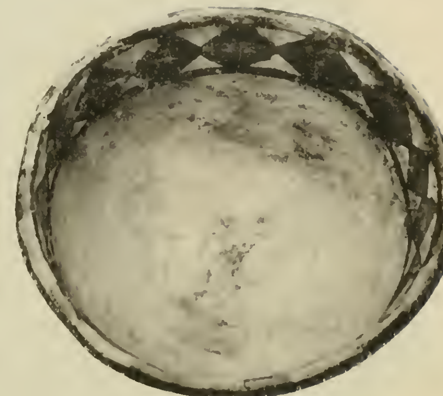
2

BLACK-ON-RED BOWLS

Fig. 1. Kayenta I(?) black-on-red. Diameter, 8 inches. From burial in refuse area west of Room 28

Fig. 2. Tusayan black-on-red. From upper portions of fill, Room 8

1



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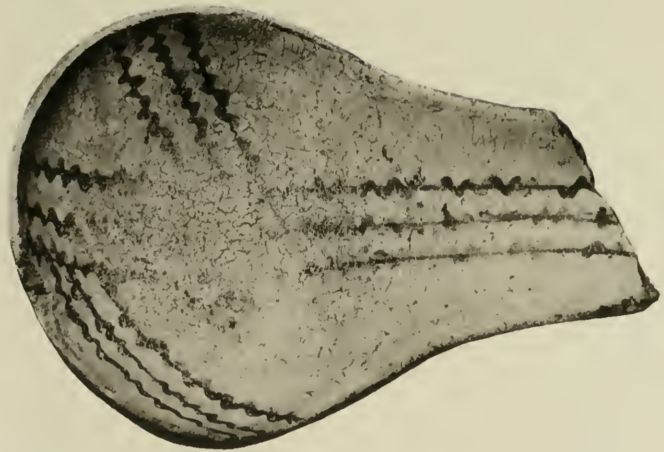
MANCOS BLACK-ON-WHITE BOWLS

Diameter of Fig. 1, 6 inches



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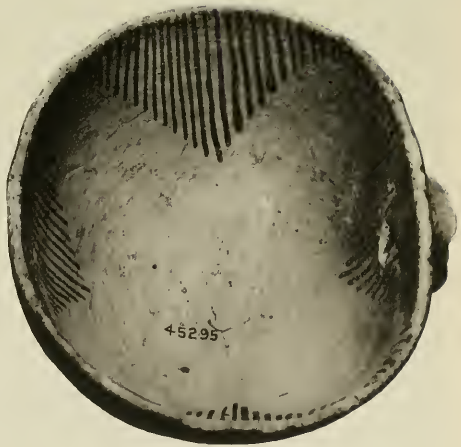

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BLACK-ON-WHITE LADLES

Fig. 1. Basket Maker III. Fig. 2. Mancos ware. Greatest diameter of Fig. 2, 4½ inches

POTTERY AS FOUND IN SITU; FLOOR OF ROOM 10

See Fig. 32

TOP VIEW OF CHACO-LIKE WALL; ROOM 15, LOWRY PUEBLO
Length of section shown, 3 feet

TOP VIEW OF NON-CHACO WALL; ROOM 14, LOWRY PUEBLO

Length of trowel, 9 inches